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THE PHYSIOLOGY, PATHOLOGY, AND CLINICAL SIGNIFICANCE OF EXPERIMENTAL CORONARY SINUS OBSTRUCTION*

ITS RELATION TO CARDIAC SURGERY, CORONARY THROMBOSIS, AND NUTRITION OF THE HEART BY THEBESIAN VESSEL OR CORONARY SINUS BACKFLOW

HAROLD F. ROBERTSON, M.B. (TOR.), B.SC. (MED.), F.R.C.S. (C.)
TORONTO, ONTARIO

THOUGH much has been learned regarding the results of coronary artery occlusion, closure of any of the veins of the heart, or of the coronary sinus which drains the heart to a large extent has not been frequently noted or the concomitant pathologic and physiologic changes detailed. In the following clinical, pathologic, and physiologic study of such closure in animals enlightenment was desired on the following points:

1. With the advance of cardiac surgery the clinician requires data regarding effects subsequent to the occlusion of the cardiac venous system, while from an experimental viewpoint these data are also valuable, especially with regard to whether ligation of veins with arteries will complicate studies on coronary artery closure.

2. During the course of these studies, physiologic changes indicating the liberation in the heart of a vasodilatory and cardioinhibitory substance were noted frequently following occlusion of the coronary sinus. The phenomenon occurred after the sinus was closed, and the usual and largest return channel of venous blood thus blocked, if the thebesian vessels did not return enough blood from the heart wall directly to the heart cavities to prevent congestion and cyanosis of the left heart. Considerable attention is paid today to the so-called cardiac hormone and to similar substances extracted from striped and unstriped muscle as well as other tissues which have a vasodilatory

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action.[1-10] The heart proves excellent for a study of such effects and their possible application for the alleviation of occlusive states of the coronary vessels. Further, these physiologic changes were correlated with pathologic findings. One hoped these findings would be valuable in that they should be those found by others to be coexistent with venous occlusion accompanied by various degrees of circulatory stasis in different regions of the body.[11, 12] Here again the heart presented itself as an excellent site for the study of circulatory phenomena of this type, many of its responses being readily noted.

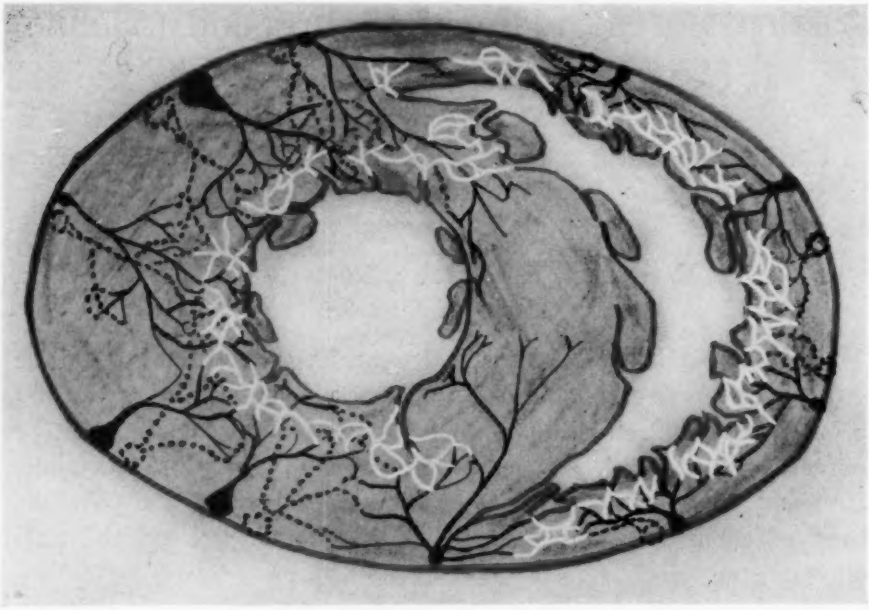

Fig. 1.—Diagramatic representation of vessels of Vieussens and Thebesius (white) forming a network of vessels in connection with coronary arteries (black solid) and coronary veins (black dotted). The left coronary artery drains largely to the coronary sinus by its veins but has connections through the network with the left ventricular cavity. The right coronary artery drains largely to the cavities of the right auricle and ventricle through the network, little arterial blood returning to the right auricle by way of coronary veins.

3. It has been suggested that blood from the heart cavities may flow into the heart wall to nourish it adequately and minimize the effects of coronary artery closure. Such a flow is said to occur along the small vessels shown by Vieussens to connect the arteries, and by Thebesius to connect the veins, of the heart wall with the heart cavities.[10, 13-17, 19, 20] If this were true and if the heart could tolerate readily closure of the coronary sinus, dilatation of the venous channels should follow such closure and subsequent coronary artery ligature should have minimal effects. Other workers have suggested that in coronary artery closure blood may flow back from the right auricle into the coronary sinus and its tributaries to penetrate the heart wall and nourish it.[13-15, 20, 21] The physiologic data in support of this concept need additions to show whether such a flow would be likely to occur and how efficient it might be.

4. Last, our work included extensive electrocardiographic studies, correlated carefully with the other data, on the assumption that venous obstruction might present pictures different or capable of differentiation from arterial closure or might enhance our knowledge of the effects of cyanosis and myocardial death on conduction curves.

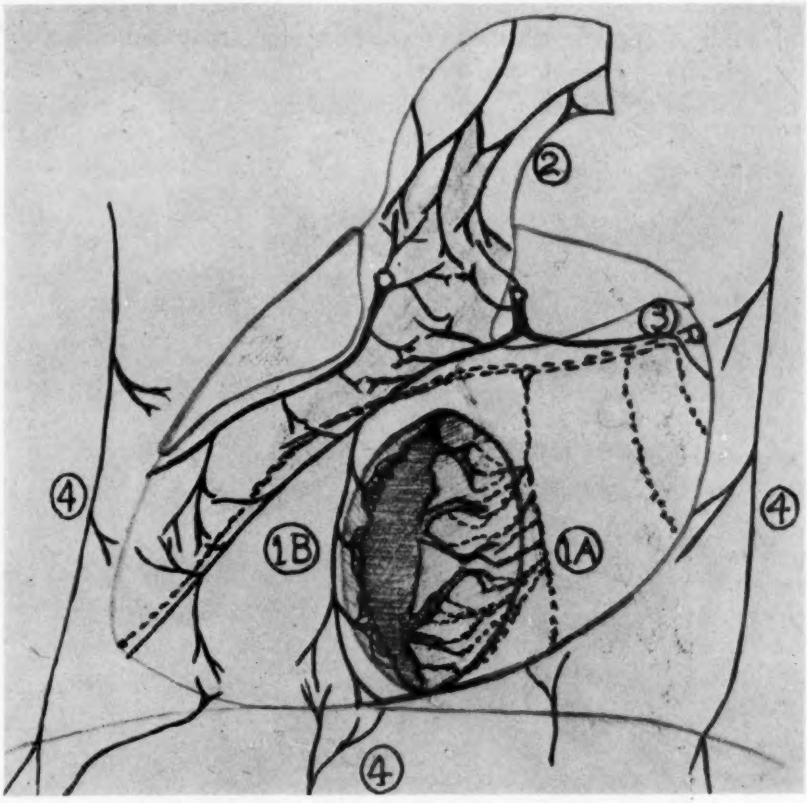

Fig. 2.—Diagramatic representation of coronary arteries in relation to vessels of Vieussens (black solid) and coronary veins in relation to vessels of Thebesius (black dotted) and of supposed accessory modes of blood supply to the heart in coronary occlusion. *1A*, coronary veins and vessels of Thebesius; *1B*, coronary artery and vessels of Vieussens; *2*, vasa vasorum of ascending limb of thoracic aorta; *3*, coronary sinus; *4*, pericardial, diaphragmatic, and other thoracic vessels by adhesions.

LITERATURE

The knowledge to date regarding these questions is summarized as follows:

Anatomy.—Vieussens and Thebesius, by injection experiments and dissections in a variety of hearts, demonstrated that small channels join the cavities of the heart with the arteries and the veins of the heart wall. It has since been demonstrated that these small vessels develop from embryonic sinusoidal channels which at first are only connected with the heart cavities, but later join the coronary arteries and veins. The size of the vessels must vary, and workers do not agree whether they are always capillary in size or whether they may have arteriolar and venular magnitude, or be even larger. They communicate very freely, however,

one with another, and with the intramural network of arteries and veins. Some attempt has been made to differentiate clearly the vessels of Vieussens, which are supposed to have to do only with the arterial side, from the vessels of Thebesius, said to be venous in character. Though anatomically vessels eventually may be associated more intimately with one or other side of the circulation, the physiologic concept is the more important and, as noted below, the whole system may functionally be grouped as one. Though clear-cut evidence is lacking, it is probable that the vessels of Vieussens and Thebesius are most numerous in the right heart, are quite numerous in the left ventricle, especially about the

Fig. 3.—Low-power photomicrograph of section of dog's ventricular wall, showing large blood sinuses running far into the wall, and almost to the epicardial surface, from the ventricular cavity.

apex, and are absent or rarely present in the left auricle. Such a distribution agrees with Thebesius' concept that the system is for rapid drainage of venous blood from the heart wall. This distribution also agrees with the fact that on the right side of the heart is found a thin and highly trabeculated wall, a short route necessary for the return of arterial blood to the right heart cavities, and a corresponding paucity of veins; while on the left side of the heart there is a thick ventricular wall and a definite and efficient venous system to carry the blood a relatively long distance to the right heart cavities[13, 15, 17-24] (Figs. 1-4).

The major veins of the right heart are about a half-dozen in number and usually enter separately into the right auricle. Several enter the sinus by way of the small cardiac vein or the right marginal vein. The veins of the left heart form a slightly variable but definite system. The veins accompanying the left coronary artery branches end in the coronary sinus, a structure 2 or 3 cm. long, which commences where the oblique vein of the left auricle and the left marginal vein join the great cardiac vein near the junction of the left auricular body with its appendage. It possesses a rather inadequate valve near its commencement and another, equally inadequate, may be seen as its termination at the right auricle.

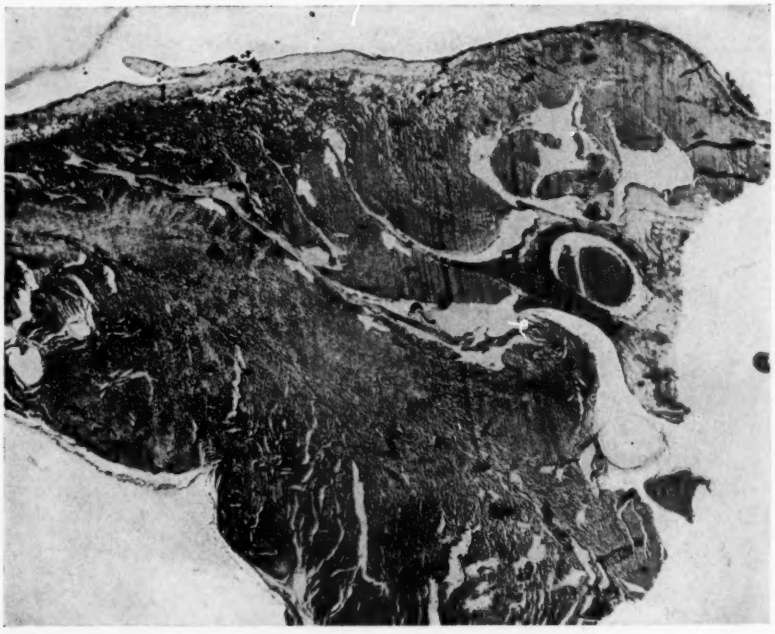

Fig. 4.—Low-power photomicrograph of section of dog's left heart wall some weeks after the coronary sinus of the heart had been ligated. Arrows trace several dilated thebesian vessels from endocardium to outer part heart wall.

Pertinent variations in these arrangements are several cases where the sinus was not patent by reason of embryonic lesions or old inflammatory lesions, yet no evidence of detrimental clinical or pathologic changes was noted in the hearts. In another case an arteriovenous aneurysm between a small artery and the coronary sinus of an adult heart had produced merely a slight dilatation of the joined vessels.[25-27]

Physiology.—It may be fairly said that Thebesius' statement of the function of the vessels now named after him, and those also of the type described by Vieussens, still holds good. The vessels connecting the intramural arteries and the veins with the heart cavities were said to act as an overflow system for more quickly emptying the heart wall in case of sudden hyperfunction of the heart. The venous drainage of the right heart wall is largely into the cavities of the right heart directly, some

blood being returned by the right heart veins and only a small fraction entering the coronary sinus by way of the right marginal or small cardiac vein. The left heart wall empties itself largely into the coronary sinus through its numerous veins. A small part of the venous blood probably enters the left ventricular cavity directly, while none likely returns from the left auricular wall to the left auricle directly but is discharged into the sinus and its veins. The average heart in this way drains over 60 per cent of its venous blood into the coronary sinus, so that the left ventricular wall must discharge considerably over this percentage of its blood by way of the coronary sinus. The discharge of blood is made during systole by the intramural pressure which, rising in this phase over the aortic pressure to shut off the coronary artery inflow, squeezes blood from the heart wall either into the heart cavities or into the coronary veins [13-15, 17-19, 28-31] (Figs. 1-5).

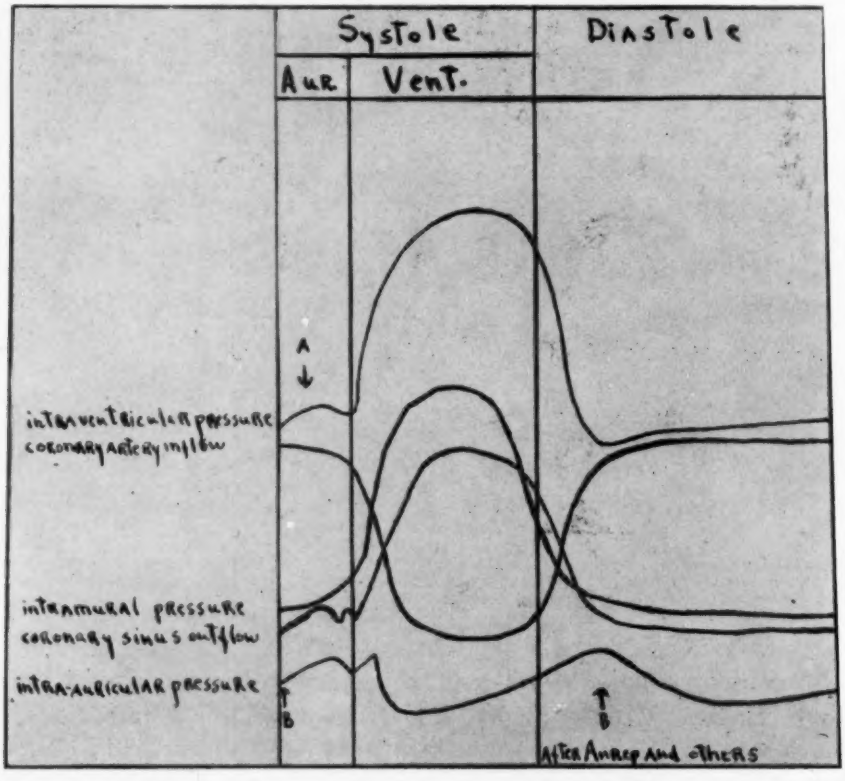

Fig. 5.—Composite diagram of various pressure curves relevant to nourishment of heart by thebesian backflow or coronary sinus backflow. *A*, Possible favorable point for thebesian backflow; *B*, possible favorable time for coronary sinus backflow.

In considering whether it is true that the thebesian vessels, as an accessory function, might nourish the heart wall in coronary occlusion by carrying blood into the wall from the heart cavities, the following physiologic data must be kept in mind. In ventricular systole there is a high intramural pressure which squeezes some of the blood from the heart wall through the valvelike slit openings of the thebesian vessels on

the endocardial surface of the heart wall. Throughout diastole not only does the coronary artery inflow distend the heart wall and tend to close the thebesian openings, but the intraventricular pressures are low. For a short period in auricular systole there is a diminution in coronary inflow and intraventricular pressures are rising, but there is already an increasing intramural pressure[28-31] (Figs. 1-5).

The nourishment of the heart by a coronary sinus backflow is perhaps favorable, on theoretical grounds, for two very brief periods: (1) during early auricular systole, just before coronary sinus outflow commences to increase and ventricular systole suddenly raises the coronary sinus and the intramural pressure; (2) during early diastole, when the auriculoventricular ring is moving upward, the intra-auricular pressure is being further increased by the inflow of blood during the time the auriculoventricular valves are closed, and intramural pressure and coronary sinus output are decreasing[28-31] (Figs. 1-5).

The experimental physiology bearing on the question of whether hearts suffering from occlusion of the coronary arteries can be nourished by the forcing of blood from the heart cavities into the heart wall is conveniently included here. Stella's experiments show that blood does not flow into the coronary arterial system from the heart cavities in the normal heart during acute experiments.[32] Robertson has shown in survival experiments on dogs that, after first dilating the thebesian vessels by ligation of the coronary sinus and then gradually occluding the coronary arteries completely, the heart is not nourished by a thebesian backflow but by the adhesions developed in the course of the experiment[48] (Fig. 4). However, various authors have shown that bacteria, and particles deposited in the heart cavities, find their way into the heart wall and the coronary venous system in some manner without first entering the main coronary arteries.[20, 21] Others have nourished hearts experimentally by coronary sinus or by intraventricular perfusion, and reports are found of human hearts maintaining their function though their coronary arteries were apparently occluded entirely or to a serious degree.[13-15, 18, 19, 33-35]

Experimental.—The effects of coronary vein or sinus ligature are mentioned by several authors. Cohnheim found that single coronary veins could be tied without damage to the heart, but that most hearts, though not all, became cyanotic if the coronary sinus was obstructed, the left heart being most affected. In one-half hour there was great bulging of the veins, dilatation of the arteries, evidence of exudation of blood into the heart wall; the heart rate slowed and sometimes cardiac death ensued.[36] Several have since perfused the coronary sinus, keeping the heart alive by this means.[13, 14] Others have blocked the sinus or tied its veins, sometimes with marked congestion of the heart wall and exudation of blood into the myocardium and fatal results as noted by Cohnheim, sometimes with only a transient slowing or a heart block and dilatation of the coronary vessels.[29, 30, 36, 37] An electrocardiographic

study showed a constant increase in the height of the T-wave.[37-39] Cohnheim and others found that ligation of the veins accompanying an obstructed coronary artery made no difference in the result of arterial occlusion.[36, 37] Added to these data are the cases quoted above, where the coronary sinus was obstructed or involved in an arteriovenous aneurysm, without functional change being present in life or evidence of myocardial damage being found at autopsy.[25-27]

Several of the above references point to the fact that a vasodilatory substance is apparently liberated in the heart when cyanosis occurs, especially in coronary sinus obstruction followed by venous engorgement.[36, 37] This substance slows the heart. It is doubtless of the group spoken of as the "cardiac hormone" and belongs in the class of nucleic acid derivatives which are known to be vasodilatory, and some of which are capable of producing heart block.[1-6, 9, 10] Though recently the physiologic properties of adenylic acid and allied substances have been tested clinically by several for their cardioinhibitory effects with unpromising results, one report states that such preparations benefit patients suffering from intermittent claudication, though not by vasodilatation in the affected parts apparently.[7-9]

The question is brought up of the wisdom of closure of the venous drainage of an area when that area's arterial supply is shut off. Recent literature indicates that the result of such a maneuver is to be based on whether or not numerous and often opposing factors will balance, so that oxidation throughout the affected portion will be enhanced.[11, 40] The problem is a complex physiologic one, rendering clinical decision hazardous, even precise physiologic determination of the result being impeded by the difficulties in collecting significant data. The main factors are the rate and volume of blood flow to, in, and from a part, the rate of O_2 utilization and the coefficient of utilization, the individual vasodilatory reaction in response to various chemical or nervous stimuli, the ability of vessels carrying blood to or from the part to change their caliber, and the fact that tissues vary within unknown limits in their anaerobic abilities from time to time and in various environments. It appears in general that, even if venous congestion following venous ligation enhances oxygen utilization and causes vasodilatation, or by other means tends to preserve a part lacking in arterial supply, at least a certain amount of tissue death, especially muscular necrosis, occurs.[11, 40]

METHOD

The experiments were acute and survival in type. In the acute experiments 6 dogs, 6 cats, 1 rabbit, and 1 monkey were used. The pressure developed in the coronary sinus when it was obstructed was measured; the pressure curve was studied, noting whether there was change in color of the heart, whether vessels dilated, or if a change in rhythm occurred. Right heart pressure was taken and general systemic effects were noted in pulse and blood pressure. Electrocardiograms were taken during

various stages to see what conduction changes took place. Pathologic studies were done in gross and by microscopic examination.

In the survival experiments 4 dogs were used. The clinical effects of coronary sinus ligation were studied and electrocardiographs were taken before and after at suitable intervals. The hearts were removed at three days, seven days, four months, and six months for gross and microscopic studies.

From another series of dogs in which coronary sinus ligature was carried out, data will be utilized occasionally, especially pathologic data from the heart of an animal sacrificed twenty-four hours after sinus ligature.

Ligation or clamping of the sinus was best done by nicking the epicardium alongside the coronary sinus and by blunt dissection freeing the sinus from its bed. During this maneuver numerous small vessels were encountered which might be ruptured unless care was taken. However, any bleeding could be controlled by pressure unless the sinus itself was torn badly. The sinus was usually tied or clamped within 1 cm. of its entrance into the right auricle. If the middle cardiac vein, in the posterior or inferior longitudinal sulcus, entered the sinus proximal to the sinus blockage, it was separately ligated to occlude completely all venous drainage from the left heart wall; and in some such hearts this final step brought about left heart congestion not previously present. Sinus pressure was studied by inserting a short-tipped cannula through the right auricular appendage and passing it across the auricle into the mouth of the sinus. Its shoulders efficiently plugged the sinus opening while the short point just entered the sinus itself. The animals' thoraces were opened through the fourth left or right costal interspace. The anesthesia was ether, delivered by a mechanically interrupted positive pressure machine. In survival experiments aseptic technique was used, the chests being closed in layers without drainage.

The electrocardiograms were taken throughout the acute experiments and, while the hearts were exposed in survival experiments, by the usual three leads and by a fourth direct lead. Additional preoperative and postoperative curves were taken in survival experiments with the animal standing, lying on its back, and lying on one side.

OBSERVATIONS

Acute Experiments.—Observations in these are conveniently grouped as noted by inspection and pressure curves, by electrocardiograms and pathologic changes.

Changes in appearance on ligation or other obstruction of the coronary sinus varied between both species and individuals. In 10 dogs used in this study, 9 showed marked bluing of the left ventricular wall with dilatation of veins and then dilatation of the coronary arteries and variations in rhythm, while only 3 out of the later series of 12 dogs showed

such changes or any change whatever. Five out of 6 cats showed moderate bluing and vascular dilatation when the sinus was tied. One cat, 1 rabbit, and 1 monkey showed no bluing of the heart or any other change in response to sinus ligation, or even wholesale venous ligature. Most of the hearts which turned blue over the left ventricle showed increasing vascular congestion and dilatation of veins, with cyanosis of the left heart during the first minute, by which time these effects had reached a maximum. The sinus was then markedly distended; the color of the left ventricle was purple; the right heart approximating the septum was blue; the auricles were unchanged. Bulging veins were especially

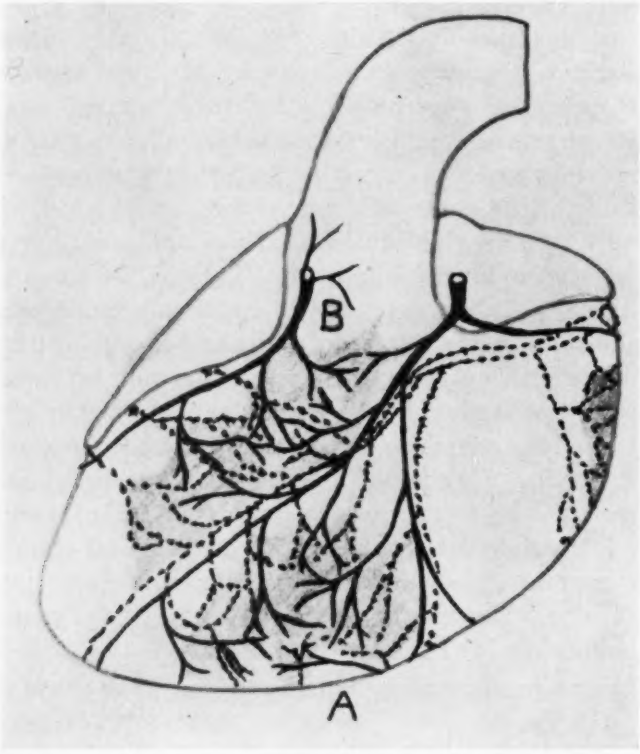

Fig. 6.—Diagram illustrating the network of small anastomosing arteries and veins which develop over the conus arteriosus (*B*) and about the apex of the heart (*A*) after coronary sinus ligation has produced congestion of the left heart wall.

marked about the apex where the posterior veins of the left ventricle, branches of the great cardiac vein, and branches of some of the right heart veins anastomose. Venous dilatation over the conus arteriosus also was marked. In these areas especially the arteries were much dilated and many fine vessels appeared in and beneath the epicardium. These could not always be identified as arteriolar, but many were much smaller than those arteries ordinarily seen over the heart's surface. They were seen also over the ascending aorta and the pulmonary artery where the main vasa vasorum stood out prominently. The main coronary arteries were much dilated. Hearts showing marked cyanosis,

congestion, and vascular dilatation developed petechial-like spots along the course of the larger vessels. These spots were more common toward the base of the heart. They were also very common over areas of vascular anastomoses, such as the conus arteriosus or the apical region, where so many new vessels had appeared. As noted below, these spots, upon microscopic study, were found to be made up of tremendously dilated capillary vessels, extravasation of blood from ruptured vessels being found present only occasionally (Fig. 6).

While these vascular changes were taking place, clear fluid formed beneath the epicardium alongside the larger vessels and became maximal in amount in about two minutes. It then gradually appeared about other and smaller vessels, seeming to spread along vessels, and away from vessels, along their branches, lifting the epicardium en route (Fig. 7).

Fig. 7.—Photomicrograph illustrating acute changes in left heart wall of dog when left heart had become congested following coronary sinus closure. There is marked exudation of serous and sometimes hemorrhagic fluid about the vessels and under the epicardium.

The changes in rhythm noted set in with the vascular responses. The heart slowed rapidly and at the same time lost contractility and dilated, the effect being vagal-like. Extrasystoles were common. In no animal did fibrillation occur nor did death occur from cardiac failure.

It was interesting to note in several animals that after a ten- to thirty-minute period of cyanosis and congestion these and other signs of coronary sinus blockage disappeared, the fluid about the large vessels diminished, and the normal rate and contractility of the heart returned. Correspondingly the coronary sinus pressure which was being recorded and which was very high began to fall and eventually,

when the heart appeared normal, approximated the level of curve shown by animals whose hearts were not affected at all by blockage of the sinus.

Unclamping or unblocking the sinus in a heart showing the usual responses led to immediate restoration of normal appearance and action except where cyanosis and congestion had been prolonged. Then, although normal function was resumed, small petechial spots or bruised areas might remain with more or less elevation of the perivascular epicardium by the clear fluid which, as noted above, had accumulated about the vessels during the sinus occlusion.

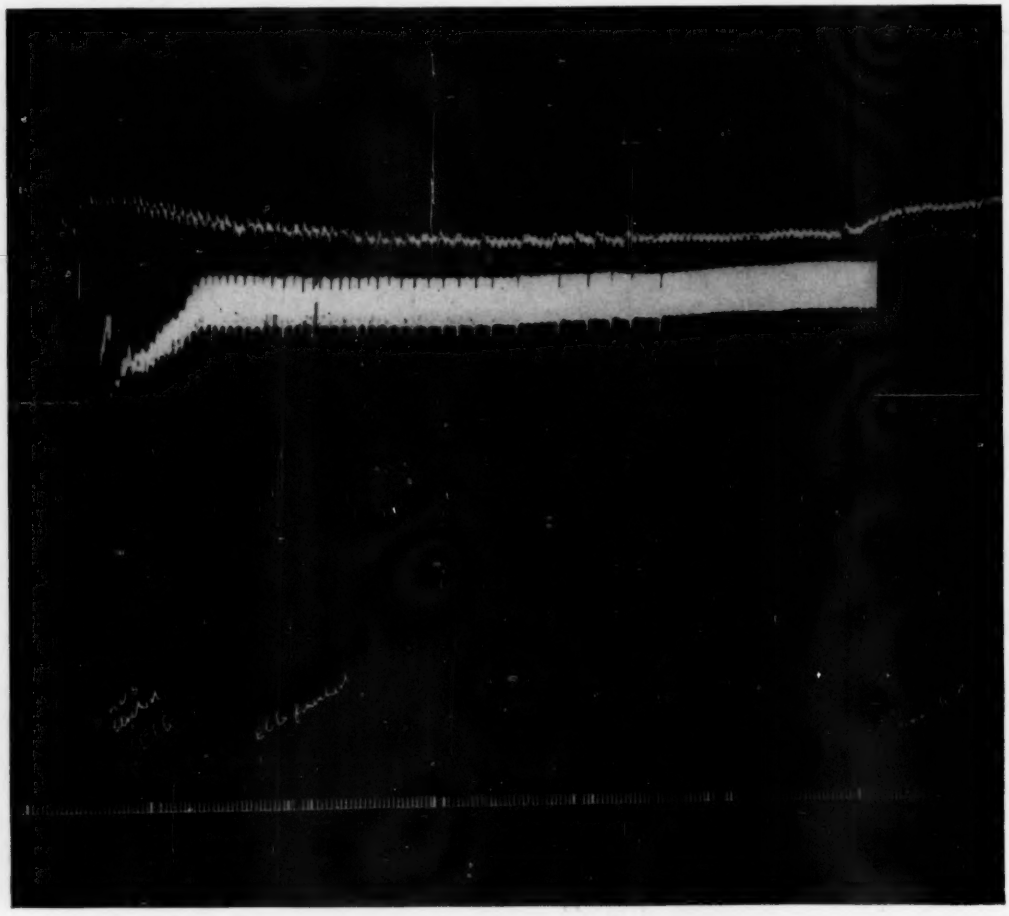

Fig. 8.—Tracing to illustrate typical carotid artery and coronary sinus pressure changes during occlusion of the coronary sinus of a dog's heart, the left heart of which became cyanotic and congested. *A*, Carotid pressure; *B*, coronary sinus pressure.

Section of the nerves to the heart was found to have no effect on the phenomenon. Though the vasodilatation seen might have been merely the result of cardiac anoxemia and increased coronary venous pressure, the marked slowing of the heart was against such an assumption.

The pressure curves corresponded excellently with the naked-eye appearances of increased venous pressure. As in the accompanying

graph, coronary sinus pressure in dog hearts, which had become cyanotic on coronary sinus closure, rose slowly to a point approximating that exerted in the heart wall (about 120 mm. Hg). This pressure was undoubtedly dependent on the pressure developed during systole by tension on the intramural veins and on the blood in veins between the heart walls and the epicardium. In diastole pressure fell off toward zero but where marked cyanosis was present pressure rarely fell below 40 mm. Hg before the next systolic rise (Fig. 8). Where there was no congestive response to sinus obstruction, the pressure rose but to a less extent, a high point of 60 to 80 mm. Hg being reached. Carotid or

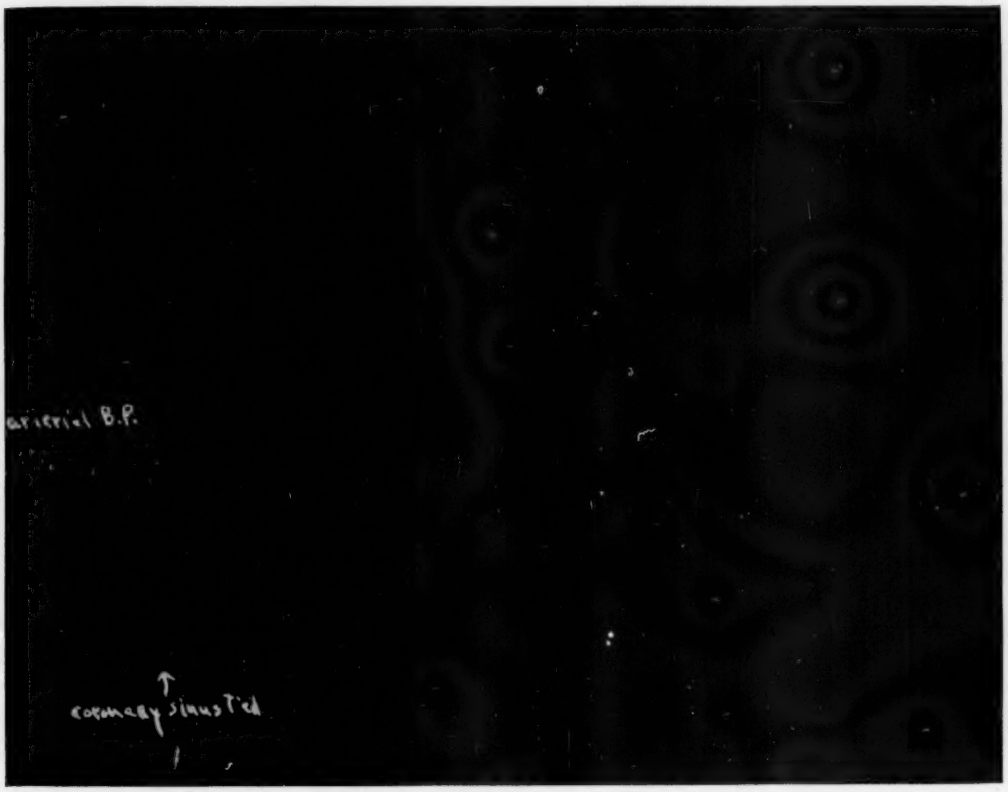

Fig. 9.—Tracing illustrating typical fall in carotid blood pressure curve after ligation of the coronary sinus in a dog whose left heart became cyanosed and congested; and then gradual recovery in blood pressure.

femoral pressure curves, when the heart was congested, occasionally showed a slight fall of from 10 to 20 mm. Hg, which tended to rise slowly if the sinus obstruction was continued and rose promptly if sinus flow was resumed (Figs. 8 and 9). Right heart and pulmonary artery pressure did not change. Cats and the one rabbit used gave similar pressure curves.

In all animals, when the sinus obstruction was removed with a return of normal appearance and function, there was a return to normal of the various pressure curves (Fig. 8).

The electrocardiographic changes, as a rule, were irrelevant and related to manipulation usually. In several, however, a splintering of the QRS complex occurred immediately closure of the sinus was accomplished. It disappeared within a few minutes of reopening the sinus or, in hearts which balanced their venous drainage while the sinus was still closed, presumably by dilatation of the thebesian vessel, the splintering diminished and disappeared as the color of the heart improved (Fig. 10).

Gross pathologic examination of specimens added nothing further to the above changes except that on cross section marked congestion of the left ventricular wall was seen. Sometimes the right ventricular wall near the septum was also congested. In the outer one-third of the left wall extravasation of blood was frequently apparent. Microscopic studies confirmed the dilatation of vessels as noted above. Vessels, especially veins, throughout the left ventricular wall were always larger than usual if congestion had been well marked. The epicardium

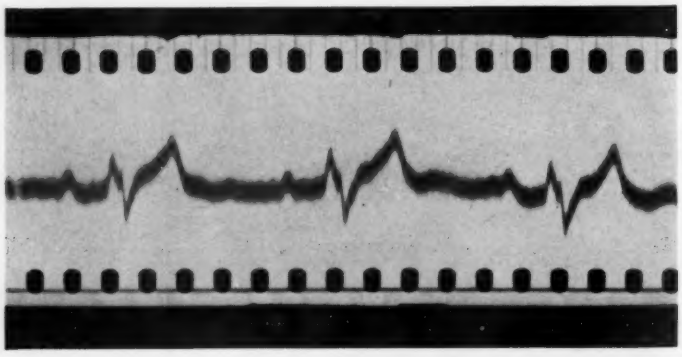

Fig. 10.—Electrocardiographic tracing to show typical splintering of QRS complex after occlusion of coronary sinus of dog's heart had produced congestion and cyanosis of the left heart.

about the larger vessels was raised, the spaces being filled with pinkish fluid as stained by hematoxylin-eosin after paraffin section. The fluid occasionally contained blood cells or tissue debris. Though no lining cells were definitely identified, it was felt that these perivascular spaces were dilated lymph channels. Their distribution certainly corresponded to that of the cardiac lymphatics as outlined by Kampmeier.[41] Within the heart wall these spaces were not seen. The petechial-like spots noted above on section usually showed dilated capillaries, but sometimes these had ruptured and there was extravasation of blood. This occurred chiefly just at or under the epicardium but was common in the outer one-third of the heart wall and rare in the inner one-third. Occasionally the myocardium was ruptured, especially at the epicardial surface, the epicardium then being torn from the muscle fibers by extravasation of blood or by exudation of the clear pink staining fluid in the neighborhood of the larger coronary vessels (Figs. 7 and 11).

Survival Experiments.—Observations are here noted under clinical, pathologic, and electrocardiographic changes. Data were obtained from four dogs of this study and pathologic data were used from another study for a description of the changes found twenty-four hours after coronary sinus closure. The four of this series showed the typical reaction with bluing of the left heart and vascular dilatation, as noted above. Two were markedly affected, it being feared that the animals would not survive. However, in these, when the pericardium was closed, contraction became stronger and several hours afterward, when the animal had recovered from ether, the pulse was strong and regular. The animals could stand without trouble a few hours after operation. Though not playful for several days, they could climb stairs without dyspnea on the first day. The other two dogs, whose hearts had turned blue but had not dilated so much, seemed no worse for the operation. They soon played quite normally and showed no change in exercise tolerance.

The pathologic changes were noted by sacrifice of the four animals of this series at three days, seven days, four months, and six months.

Upon opening the chests of other dogs twenty-four hours after ligation of the coronary sinus had produced the typical acute changes of congestion, bradycardia, etc., a characteristic bruised appearance was seen over the left ventricle, conforming to the area of congestion and cyanosis. No dilatation of the main veins was seen though in areas of anastomoses, as over the conus arteriosus and about the apex of the heart, numerous and prominent vessels, both arterial and venous, were seen (Fig. 6). An elevation of the epicardium along the main vessels was still present, produced by an accumulation of opaque material, while spreading from the main vessels were grayish opacities just beneath the epicardium. The opaque material was apparently organized serous fluid. Petechial-like spots were still usually present but were decreased in number. Microscopic examination of sections stained by hematoxylin and eosin demonstrated changes in the bruised areas varying from early edema and cloudy swelling with granulation of muscle fibers to typical necrosis of muscle following congestion and hemorrhagic infarction described by Middleton.[12] The necrosis usually existed only in the outer one-sixth of the left heart and was rarely found in the right heart. Some portions of the left heart were more severely damaged, necrotic patches being present, as deeply as the midportion of the wall. Beneath the epicardium of the left ventricle and scattered throughout the outer one-half of the wall were greatly distended venous channels and smaller vessels of capillary size. Some of these had ruptured, extravasating their contents nearby and rupturing surrounding muscle tissues or tearing epicardium away from the myocardium. Sections of the inner part of the left wall showed areas of vascular dilatation corresponding to the superficial areas of congestion. Veins, arterioles, and capillaries were dilated. None were ruptured nor was there perivascular exudate or transudate. The petechial-like areas were found

mostly to be widely dilated capillaries but sometimes extravasation of blood was also present in these areas. The grayish elevated markings alongside the larger superficial blood vessels were found to contain

Fig. 11.—Photomicrograph of section of left heart wall twenty-four hours after ligation of coronary sinus had produced congestion of left heart in dog. Some areas of necrosis are seen in center of section.

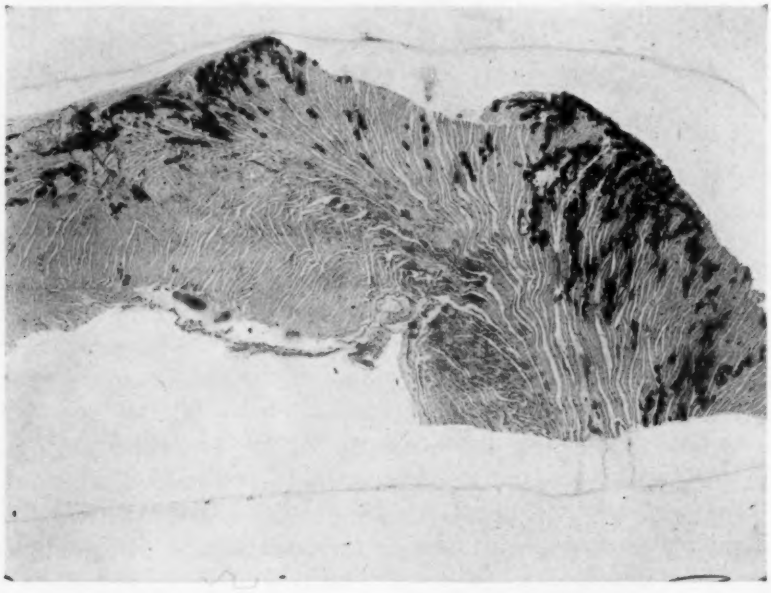

Fig. 12.—Photomicrograph to illustrate necrosis in dog's left heart wall after coronary sinus obstruction had caused cyanosis and congestion of left heart.

pink staining homogeneous material in which white cells and connective tissue cells were scattered. No definite endothelial or mesothelial wall could be made out for these spaces as a rule. The grayish sub-

epicardial patches diffusely distributed around the smaller superficial vessels were found to consist of collections of pink staining material more or less dotted by blood cells and remnants of muscle or connective tissue cells. There was no limiting membrane found around these collections nor were they definitely associated with the larger spaces about the main coronary vessels (Figs. 11 and 12).

The heart of a dog sacrificed on the third postoperative day showed similar bruising of the left heart. There was no evident dilatation of the large arteries or veins. In the anastomotic areas about the apex and across the conus arteriosus, enlarged medium and small vessels were conspicuous (Fig. 6). The main vessels were still more or less surrounded by a grayish subepicardial material and scattered patches of an apparently similar nature lay along or around smaller vessels. No petechiae were seen. Microscopic examination revealed necrosis in the outer one-sixth of the left ventricular wall much more marked than in the twenty-four-hour specimens. Some portions of the left heart were more severely damaged than others, necrosis extending to the midpart of the wall with rupture of vessels and extravasation of blood both superficially and deeply. In the inner half of the left ventricle, in areas corresponding to these outer necrotic parts, marked dilatation of veins was present, while arterioles and capillary vessels were also dilated. The right ventricle showed only occasional and small areas of connective tissue reaction, chiefly in the outer one-sixth, with myocardial fibrillation and vacuolization. Where the epicardium had been raised from the myocardium or away from the larger vessels, with extravasation of blood or the occupation of these areas by the homogeneous material described above, connective tissue proliferation was now seen with well-advanced organization. Such connective tissue organization was also well started in those areas deeper in the wall where extravasation of blood with rupture of muscle had taken place as well as about areas of necrosis (Fig. 12).

The heart of a dog sacrificed after seven days showed no bruising of the left heart. Only a slightly prominent collection of grayish material was present about the larger left coronary vessels. No bulging of the sinus or the larger veins or the arteries was seen. There was definite enlargement of the veins about the apex of the heart which carried on an anastomosis between the veins of the left heart and the posterior veins of the right heart emptying into the right auricle. The veins of the left ventricle also anastomosed with the right heart veins by enlarged vessels over the conus arteriosus. Many new and prominent vessels of venular or arteriolar size were present in these parts. Various sections from the left ventricle demonstrated very slight swelling of muscle cells with occasional nuclear changes and separation of cells in the outer one-third of the wall. There were very rare patches of necrosis or other evidence of hemorrhagic infarction. There was very little of

the pink staining perivascular material noted above. What was found was well organized. The right heart muscle was intact.

A heart examined four months after the sinus was tied presented no enlargement of the main vessels. There were gray streakings and patches alongside the large vessels of the right heart. A whorl of veins and arteries not normally present was found at the apex, and the veins and arteries across the conus arteriosus were unusually large and numerous. Sections from the left heart showed subepicardial scarring about the larger vessels, corresponding to the gray streakings seen in the gross. Around larger vessels in the outer one-half of the wall scarring of myocardium was seen. The right heart was normal on section.

Six months after sinus ligation a heart presented no enlarged vessels even at the apex or over the conus arteriosus. Subepicardial scarring was present around the larger vessels and scarred areas were seen associated with larger vessels in the outer one-half of the wall.

Both the four-month and the six-month postoperative specimens had an increased number of vessels of a venous nature in the inner part of the left ventricular wall (Fig. 4).

The characteristic change in the electrocardiograms was a splintering of the QRS complex (Fig. 10). This change paralleled the onset of left heart cyanosis, dilatation of the coronary vessels, and the bradycardia. This splintering in acute experiments always disappeared if the sinus were unclamped and it always disappeared in survival experiments after several days when, as noted above, dilatation of the coronary sinus and the phase of acute left heart congestion was ended. Extrasystoles and flutter were noted, but only while the heart was exposed. The T-wave was so variable that no statement could be made regarding its changes.

DISCUSSION

It appears that ligation of one or several of the coronary veins of the human heart is unlikely to produce significant trauma to the heart or interference with function. Ligation of the coronary sinus in animals is occasionally followed by a marked vasodilatation of the coronary vessels, slowing of the heart, and later hemorrhagic infarction and muscular necrosis of the left ventricular wall. This reaction might occur in human hearts and would be dangerous, though perhaps not fatal. Just as in animal studies, human hearts would doubtless differ in their reaction to venous obstruction, some likely showing no change whatever. Hemorrhage from cardiac veins can therefore be checked fairly safely either by pressure and ligation or by ligation alone.

Whether or not ligation of the cardiac veins in man would result in pain cannot be definitely stated. Presuming that, as regards pain, the effects of coronary vein or sinus occlusion could be compared to the

effects of coronary artery ligature, it is unlikely that pain would be produced. Several cases are reported in which large coronary arteries, and usually the veins also, were tied off during suture of a stab wound of the heart, and in which no pain resembling that of coronary thrombosis or angina pectoris was evident at any time. No general anesthetic was used in these cases, mere local infiltration of the precordium being done. That some infarction had occurred was proved by electrocardiography.[42, 43] Cases suffering from coronary thrombosis, with comparable areas of myocardial infarction following on similar amounts of coronary artery occlusion, present a wide variation in the pain response. Pain in the experimental animal is hard to assess. Severe pain evidently results from acute coronary artery occlusion in the conscious animal.[44-47] However, dogs that have had large coronary arteries ligated under ether anesthesia sometimes appear perfectly free of pain immediately on recovery from anesthesia, while others, though perhaps uncomfortable, suffer no acute pain. The same variation in reaction is seen in dogs that have had the coronary sinus closed and have exhibited similar amounts of left heart cyanosis and congestion, some appearing absolutely free from pain, others appearing somewhat miserable but not being actually in pain. Finally, if it were true that the pain of occlusive lesions of the coronary arteries depended solely on relative oxygen deficiency in functioning myocardium and that the same held true for occlusion of the coronary veins and the coronary sinus, it would be unusual for pain to be produced by the later lesion. Hearts of different species vary widely in the amount of congestion, cyanosis, and infarction that follows on ligation of even the coronary sinus; many show no change whatever, and, as pointed out above, even those that do exhibit congestion and cyanosis after sinus occlusion give no evidence of pain.

The vasodilatory reaction seen in some animals following coronary sinus occlusion resembles the reaction following the application to the heart of vasodilatants, such as adenosine or adenylic acid.[1-6] The reaction following coronary sinus ligature occurred after all the nerves to the heart had been severed. It is possible, of course, that the vasodilatation was due merely to a combination of cardiac anoxemia and increased pressure in the coronary vascular system, but the slowing of the heart beat was against such an explanation. In such reactions not only do the coronary vessels dilate, but the heart is slowed and perhaps the likelihood of fibrillation is lessened.[1-4] It would be obviously impractical and dangerous to tie the coronary sinus to produce such a reaction when the nutrition of the heart became deficient through coronary artery occlusion. It would seem expedient, however, to test the effects of vasodilatory substances, such as adenylic acid or adenosine, when applied directly to ischemic heart muscle. Intravenous use of adenylic acid and related substances appears to be relatively ineffective in animals and in man, possibly because of its rapid loss of potency once free in the blood stream.[3, 7, 8] As adenylic acid rapidly loses its potency when free

in the body, it would need to be applied constantly to the heart, but in such quantity that coronary artery vasodilatation would be maintained, without a general vasodilatation occurring, with a fall in blood pressure and a consequent slowing effect on the coronary inflow. Such a procedure might minimize the effects of coronary occlusion. In several animal experiments this result has been demonstrated. It must be remembered, however, that, when coronary thrombosis occurs, accessory vessels may be too sclerosed to dilate adequately. Moreover, nearly all cases of coronary thrombosis show a marked fall in blood pressure and in some cases aortic blood pressure might be so reduced that coronary vasodilatation might slow coronary blood flow enough to further thrombosis. There is also the question of whether adenosine might behave like some nucleic acid derivatives and produce an increased local leucocytosis detrimental to both the heart and pericardium. In a recent report insulin-free pancreatic extract, a skeletal muscle extract, adenosine phosphoric acid, and adenosine, administered intramuscularly, have been found to inhibit intermittent claudication to a degree. The drugs thus administered were quite harmless. The beneficial effect was thought to be due not to vasodilatation, but to the addition of some substance to ischemic contracting muscle without which pain occurred.[9]

The pathologic data noted above confirm the opinion that closure of an area's venous outflow, when its arterial inflow is shut off, is not without danger.[11, 40] In the heart when venous outflow interruption did produce a vasodilatory reaction, more or less muscular necrosis ensued for the reaction appears to be brought about only when venous congestion occurs. This result occurred not only if the venous outflow alone was tied, but when one of the main coronary vessels also was tied. It is true that the results of such experiments on the heart cannot be too closely applied to the results of similar procedures on a limb. The heart at each contraction elevates the cardiac intravenous pressure markedly. This may force blood out of the heart wall via the thebesian vessels and avoid too extreme and dangerous engorgement. This may be done so efficiently that no venous blood is actually retained and no congestion of the heart wall and subsequent vasodilatation results. On the other hand, such pressure elevations are sometimes sufficient to rupture vessels and cause local areas of myocardial necrosis. Besides this functional difference between the heart and other parts, the coronary circulation is prone to overlap and thus provide numerous anastomoses in such a way that ligature of one coronary artery does not leave a preparation very closely resembling a limb with its main artery tied. It seems reasonable to suppose that when, by tying the venous outflow of a limb, the chances of gangrene are diminished, this result is accomplished because venous blood cannot find easy exitus, congestion ensues and vasodilatation, with also more or less tissue death, especially muscular necrosis.

The evident function of the thebesian system of vessels, which functionally includes the network of small vessels connected with arteries and

described by Vieussens, is to carry blood into the heart cavities or into the epicardial venous network during cardiac contraction and thus to empty the heart wall. It would seem improbable that in either normal or abnormal hearts this function should be reversed so that in ventricular systole blood would flow into the heart wall along the thebesian vessels, or the vessels of Vieussens, against a high intramural pressure and against the outflow of venous blood. In hearts exhibiting coronary artery occlusion during diastole and early auricular systole, such a possibility might be entertained in spite of low intraventricular pressure, because the coronary artery inflow, which ordinarily occurs during this period and tends to bulge the heart wall and close the slitlike endocardial openings of the thebesian network, would be diminished. The most favorable time would appear to be early in auricular systole as intraventricular pressure is rising and coronary inflow is falling off, but at the same time intramural pressure is also rising and venous blood is about to be forced from the heart wall (Fig. 5). It was found that by coronary sinus ligation it was possible to enlarge the thebesian-like vessels of the heart wall (Fig. 4). Recently a series of hearts so prepared was subjected to coronary artery ligations. They did not appear to gain adequate nutrition via the dilated thebesian-like vessels, for, when vascular adhesions that had formed during the experiments between the heart wall and various structures of the thoracic cavity were separated, the hearts failed through lack of blood supply.[48]

It seems that, as Stella contended after experiments on perfused hearts, a thebesian vessel backflow into the heart wall is improbable. In criticism of Stella's work it has been said that his experiments were a too brief test of the backflow theory and that longer experiments were in order.[18, 19, 32] It appears, however, that even in the intact healthy animal and even after the thebesian network of the heart has been dilated over a long period, no backflow takes place when the coronary arteries are gradually closed.[48]

A flow of blood from the right auricle into the coronary sinus and thus to the heart wall seems improbable and in any event unlikely adequately to nourish the heart. Such a flow seems possible during two very short periods. Very early in auricular systole blood might be forced into the coronary sinus if the sinus outflow had not already become augmented too greatly. Early in diastole a coronary sinus backflow might occur as the intra-auricular pressure rises, intramural pressure falls, and sinus outflow is decreased. Later in diastole very little pressure exists within the right auricle and, unless coronary occlusion were marked, coronary inflow, by filling the heart wall, would leave little space for any venous backflow into the myocardium (Fig. 5). No evidence of a suction of blood along the sinus into the heart wall was seen in these experiments.

Congestion and cyanosis of the left ventricular wall, following occlusion of the coronary sinus, give a constant splintering of the QRS com-

plex, W or M in fashion (Fig. 10). Similar electrocardiographic findings have been reported in studies on man. The phenomenon is rarely found in the normal, but it is apparently closely associated with occlusive lesions of the coronary arteries or with myocardial disease.[49-51] It would seem that lack of normal blood supply and congestion of the heart muscle from other causes than occlusion of the coronary arteries might give electrocardiographic findings similar to those of coronary artery occlusion. It might be that in experimental studies of coronary artery closure care should be taken not to include the vein with the artery, though thus far several report that this circumstance has given rise to no change from the usual picture of coronary artery closure.[37-39] In autopsies on patients dying of coronary disease examination of the venous system of the heart should not be neglected, especially where splintering of the QRS complex has been present. The splintering of the QRS complex commenced with left heart congestion, vasodilatation, and cardiac slowing and remained present in acute experiments until the sinus was unblocked and congestion disappeared. In the survival experiments, where marked congestion of the left heart occurred with splintering of the QRS complex, the splintering disappeared in about twenty-four hours or at about the time congestion would be disappearing as judged by pathologic studies. It seems that congestion, cyanosis, and anoxemia of the heart wall account for the splintering effect. The typical changes of coronary occlusion have previously been attributed by various workers to myocardial ischemia and oxygen lack alone.[39, 52] However, it is also during the stage of rapidly progressing cellular trauma and death that the splintering of the QRS complex is seen. After twenty-four to forty-eight hours the acute degenerative changes have mostly taken place in the heart wall and resolution with fibrosis has commenced.

SUMMARY

1. Variations in cardiac function and morphology, produced by coronary sinus occlusion, or by occlusion of the veins of the heart, depend on the varying number and efficiency of the venous and thebesian anastomoses which drain the heart wall. Thus, with insufficient or inefficient venous and thebesian anastomoses large enough degrees of venous occlusion may produce congestion of the heart wall, slowing of the heart, dilatation of the veins and the arteries of the heart, and myocardial necrosis.

The coronary sinus of dogs, cats, and monkeys in many instances can be completely and suddenly occluded, where it enters the right auricle, without producing any significant change in cardiac function or morphology. Sometimes, however, in dogs especially, left heart congestion occurs, with slowing of the heart, dilatation of both the arteries and the veins, and a moderate to severe degree of myocardial necrosis. Such a reaction does not usually endanger cardiac function gravely. In a large

series of dogs no death occurred from the effects of coronary sinus ligation, but the myocardial changes produced would not prove beneficial to a heart already suffering from other pathology.

Individual cardiac veins in the dog, cat, and monkey can usually be tied without change or with very slight change in cardiac morphology. Ligation of the larger veins or of groups of veins sometimes leads to a small amount of myocardial necrosis, but produces no marked change in cardiac function or morphology.

2. Thebesian vessels can be dilated by tying the coronary sinus. In most hearts they dilate so readily that, when the coronary sinus is closed, the venous blood of the left ventricle is rapidly forced into the left ventricular cavity and no congestion ensues.

3. When venous congestion of the left heart wall occurs, following coronary sinus closure, it gives rise to a vasodilatation of the coronary vessels and to slowing of the heart. This reaction resembles that seen after intravenous or intracardiac administration of adenosine or similar substances and suggests the local application of such substances to the heart in cases of coronary thrombosis.

4. This study supports the contention that tying the main vein, from a part already deprived of its main arterial supply, is likely to cause muscular necrosis, sometimes of serious enough degree to offset any possible advantages of the procedure. Such a procedure, if it causes significant vascular congestion with increased oxygen utilization and vascular dilatation, apparently may induce muscular necrosis in the affected part.

5. A consideration of the coronary sinus outflow and pressure curves, in relation to the cardiac cycle and cardiac pressure curves, prejudices one against either a thebesian vessel backflow or a coronary sinus backflow as a source of nutrition to hearts deprived of their ordinary blood supply.

6. The occlusion of coronary veins makes no change in electrocardiographic curves. Occlusion of the coronary sinus, if no congestion and cyanosis of the left heart wall ensues, makes no change in the electrocardiographic curves. If congestion and cyanosis ensue, then splintering, M or W in form, of the QRS complex is seen. It may be that lack of oxygen in ventricular muscle accounts for this phenomenon, as it disappears in acute experiments the moment congestion is relieved by unclamping the sinus; and in survival experiments it disappears in twenty-four to forty-eight hours when left heart congestion has disappeared.

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PHYSIOLOGIC ADJUSTMENT IN SUBLETHAL REDUCTION OF LUNG CAPACITY IN DOGS*

F. J. PHILLIPS, M.D., W. E. ADAMS, M.D., AND L. S. HRDINA,
CHICAGO, ILL.

(From the Department of Surgery, University of Chicago)

IN KEEPING pace with the recent advances in the development of chest surgery, further vital considerations arise regarding the coincidental lung changes and the compensatory respiratory physiology in intrathoracic operations. The absolute lung capacity requirement for normal respiratory function is doubtless individually variable. It may be governed by the volume of functioning lung and by the efficiency of lung tissue available. That a wide margin of safety in normal lung capacity exists in both man and animals is no longer questionable. From studies in metabolism it is well recognized that body surface area is a definite entity in determining the respiratory requirement in the human organism. In the dog a different relationship exists because of the lack of sweat glands in the skin. In this animal it is necessary for the lungs to assume the added functions of heat regulation and maintenance of water balance. Therefore, an absolute minimal functionate lung in the dog would, from a physiologic consideration, be relatively something in excess of sublethal in the human organism. Because of its acceptable size and economic accessibility the dog has been most frequently used in experimental studies of respiratory function in collapse therapy and other problems in thoracic surgery.

Thoracoplasty as such has been utilized very little in dogs. Curiously enough the mortality rate in dogs following thoracoplasty has been discouraging. However, lobectomy and pneumonectomy are now not fraught with grave danger. Collapse of a lobe or of several lobes of the lung by any method other than thoracoplasty has been very successfully performed in many laboratories. Gluck, in 1881, removed the entire lung on one side from six dogs and eight rabbits.[1] Two of the rabbits lived. His failure was due mainly to technical errors. Friedrich, in 1908, applying the technical principle of ligating the pulmonary vessels separately, succeeded in performing pneumonectomies without a discouraging fatality.[2] More recently, improvements in surgical technique have made it possible to perform the operation without mishap in from 80 to 90 per cent of the attempts.

Amputation of a lobe of the lung for tumor and for bronchiectasis in man was done as early as 1907 by Gluck,[3] and later was greatly improved by Sauerbruch.[4] Total pneumonectomy was performed in dogs

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by Rolandus in 1492.[5] This operation has been performed successfully on the human organism only within the last decade.[6] Experimental studies on diminished lung volume were begun in this clinic almost with the opening of the research laboratories in 1927. Progress in this work was enhanced by the development of a safe and reliable method of closing large bronchi.[7] Occlusion of the bronchus and eventual massive collapse in any lobe of the lung was accomplished by simply painting the entire circumference of the lumen of the bronchus with a 35 per cent aqueous solution of silver nitrate.[8] This development, coupled with improvements in surgical technique of lobectomy and pneumonectomy, paved the way for further studies on lung function. Drastich, Adams, Hastings, and Compere in 1934, found that dogs with only 50 per

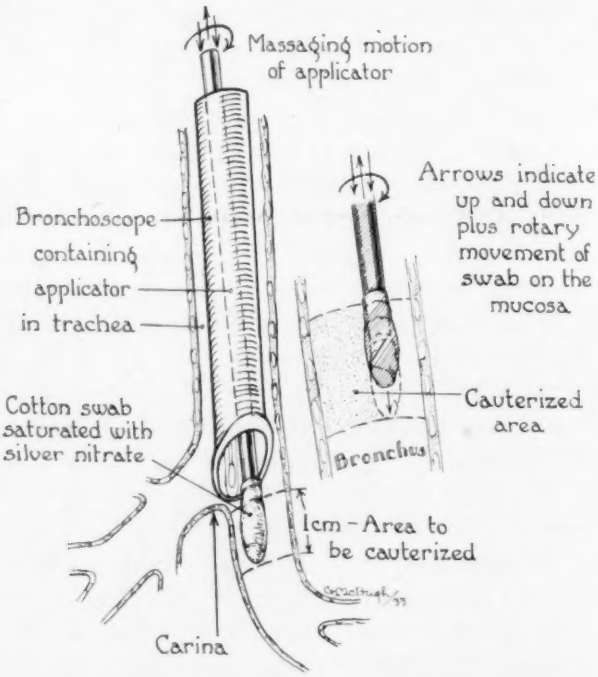

Massaging motion of applicator
Arrows indicate up and down plus rotary movement of swab on the mucosa
Bronchoscope containing applicator in trachea
Cauterized area
Cotton swab saturated with silver nitrate
Bronchus
1cm - Area to be cauterized
Carina

Fig. 1.—Diagrammatic illustration of the applicator containing a 35 per cent solution of silver nitrate which is being applied to the bronchial mucosa. The entire circumference of the bronchus must be cauterized, and the arrows indicate the two directions of movement during the application of the cauterizing agent.

cent of their pulmonary tissue functioning have no apparent difficulty in delivering an adequate supply of oxygen to the tissues.[9] They also observed that partial lung collapse leads to greater acid-base changes on exercise than does partial pneumonectomy. This variation was attributed to the fact that during rigorous exercise a significant fraction of the blood continues to flow through the remaining collapsed lung tissue. Andrus, as early as 1923, demonstrated that there was as much as 40 per cent increase in blood flow through the opposite lung within a few hours after pneumonectomy.[10] In later studies he observed that the respiratory volume, the pulse rate, the circulation through the aerated

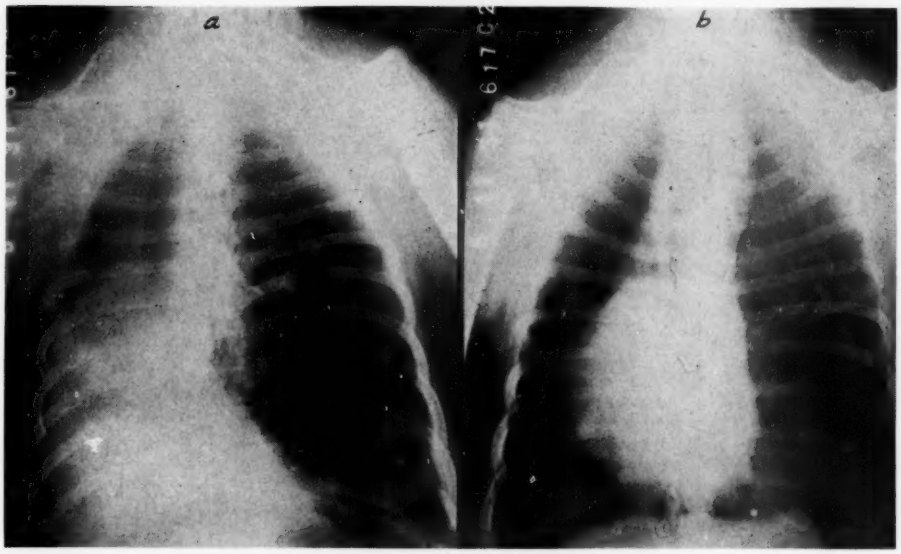


Fig. 2A.—Dog 617. *a*, X-ray of chest of dog following complete atelectasis of the right lung by bronchial stenosis. Note marked shift of the mediastinal contents to the right and elevation of right diaphragm. *b*, X-ray of same dog following complete atelectasis of left lower lung lobe by bronchial stenosis. Note the spontaneous pneumothorax (right), with a shift of mediastinal contents back to the midline.

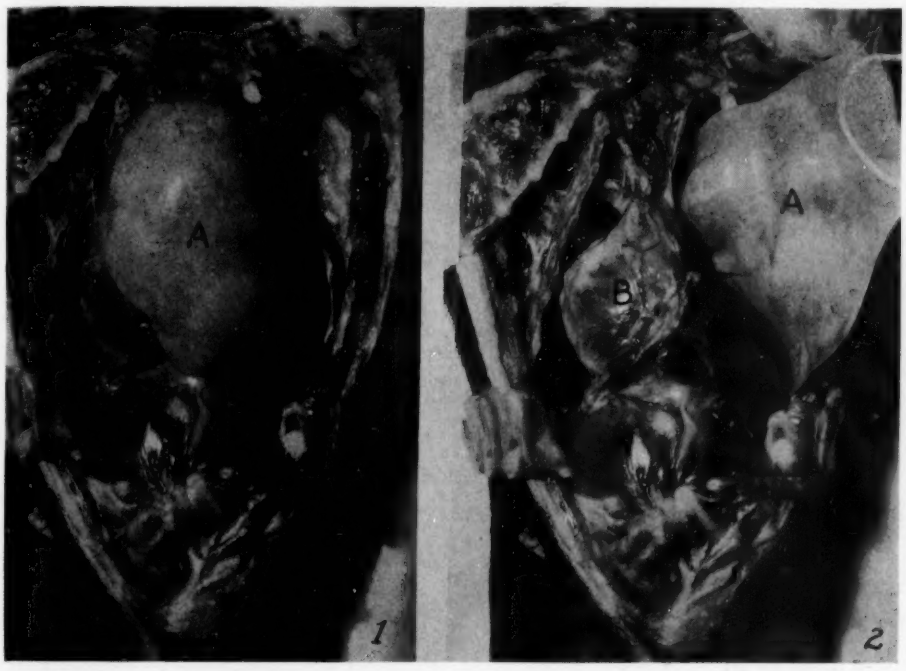


Fig. 2B.—Dog 617. *1*, Photograph at autopsy twelve days following atelectasis of left lower lung lobe. Note (*A*) overdistended left upper lung lobe, (*B*) heart, (*C*) atelectatic right lung all shifted toward the right side. *2*, Dog 617 with left upper lung lobe lifted. The atelectatic left lower lobe *D* is now visible. The pneumothorax had been partially reabsorbed. No fluid was present in pleural cavity.

lung, the hemoglobin, and red blood cell count were all apparently increased within twenty-four hours after ligation of the left main bronchus.[11] Heuer and Andrus observed a temporary rise in alveolar carbon dioxide and a fall in alveolar oxygen following pneumonectomy.[12] Associated with these alveolar air changes was a temporary rise in carbon dioxide content and capacity of the blood and a marked fall in oxygen content. There was also a marked decrease in the percentage

Fig. 3A.—Dog 749. Photograph of chest at autopsy two days following complete atelectasis of right lower and right middle lung lobes. The heart has been removed. Note (*A*) overdistended right upper lung lobe, and (*B*) completely atelectatic right lower, middle, and accessory lung lobes. The left lung had been extirpated. (See Table II.)

of oxygen saturation. The increase in hemoglobin persisted. After approximately one month all of these changes except the increased hemoglobin and oxygen-carrying capacity returned to normal. Adams and co-workers, in studies on vascular changes in pulmonary atelectasis, demonstrated a decreased volume flow of blood with a coincidental passive congestion of the atelectatic lung.[13]

Various methods have been used in attempts to produce changes characteristic of hypertrophic osteoarthropathy.[14] None of these procedures

has been successful. No physiologic explanation for their failure could be formulated. The present experimental studies are being carried out over a long period of time purposely in an effort to observe the eventual anatomic and physiologic status of animals with diminished lung tissue.

Investigators cited in earlier paragraphs have described the immediate changes that transpire during diminution of lung volume. We have attempted to assimilate in dogs physiologic conditions existing in the human organism after collapse therapy and after amputation of various integral units of the lungs. The technical procedure of producing diminished lung volume was carried out in stages. From one month to six weeks was usually allowed to elapse between operations on the lobes

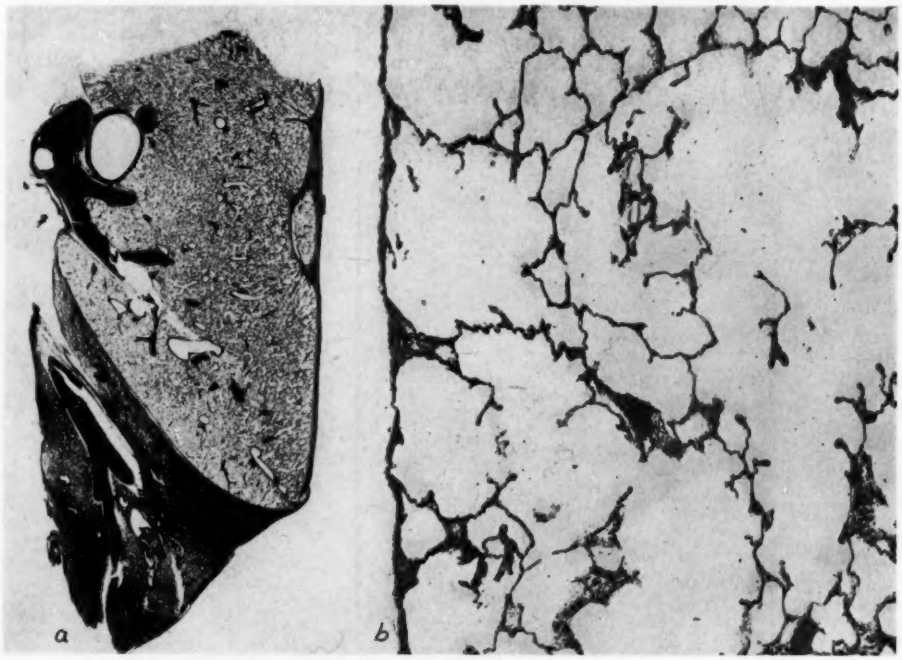


Fig. 3*B*.—Dog 749. *a*, Low-power microscopic section of lower half of overdistended right upper lung lobe and atelectatic right middle lung lobe.
b, High-power photomicrograph of peripheral portion of right upper lung lobe. Note marked compensatory emphysema.

or stenoses of the bronchi. Laboratory observations were made on the dogs previous to any attempt at diminution of lung volume. Since dogs apparently withstand pneumonectomy well, the first procedure was to remove surgically the entire left lung, utilizing Friedrich's principle of separate ligation of the pulmonary vessels. Blood analyses and bronchoscopic and x-ray examinations were made at indicated intervals. The lung volume was then further decreased by stenosing individual bronchial orifices of the remaining lung. This was accomplished by the technique mentioned above. The dogs were observed at daily intervals for evidence of air hunger. There were three animals alive and active nineteen months after the institution of the experiment. These dogs

are being kept under ordinary conditions in the animal house. Occasional observations are made on their blood to note the effect of this prolonged diminished lung capacity. These observations will be reported at a future date.

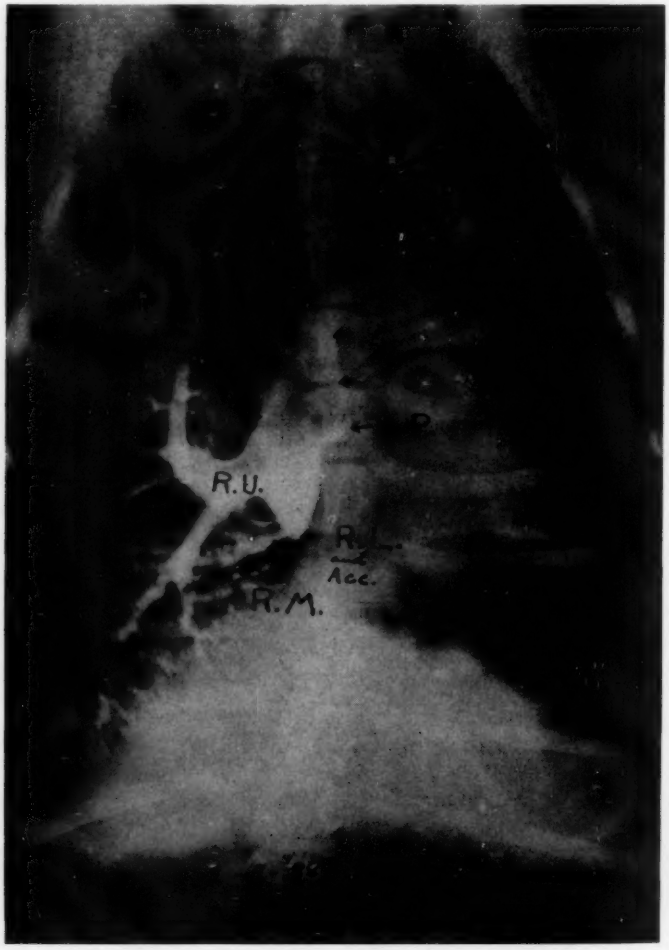


Fig. 4A.—Dog 748. X-ray of chest following iodized oil filling of bronchial tree (Feb. 8, 1938). (See Table I for date of collapse of various lung lobes.) Only the right upper and middle lobe bronchi are open. Note pneumothorax on left.

PROTOCOL OF DOG 748

The lung capacity was reduced subtotally by bronchial stenosis and atelectasis of over two years' duration. The right upper lobe remains inflated; the dog is well and active.

Sept. 21, 1937: The dog was a healthy appearing male mongrel weighing 9.0 kg. Bronchoscopy was carried out under morphine anesthesia. The left upper and lower lobe bronchi were cauterized with a 35 per cent solution of silver nitrate.

Oct. 5, 1937. Bronchoscopy: The left primary bronchus was almost completely stenosed; it was recauterized with $AgNO_3$. The right lower lobe bronchus was cauterized with a 35 per cent solution of silver nitrate.

Oct. 8, 1937. Bronchoscopy: The left primary bronchus was occluded. The right lower lobe bronchus presented a 3 mm. opening. $AgNO_3$ was applied to the right lower and accessory (subcardiac) lobe bronchi.

Jan. 15, 1938. Bronchoscopy: The right lower and accessory lobe bronchi were occluded. X-ray examination of the chest showed the heart and atelectatic left lung in the left half of the lung field. No pneumothorax was present.

Feb. 8, 1938: Intrapleural pressure readings were:

	EXPIRATION	INSPIRATION
Left	11 cm. H_2O	14 cm. H_2O
Right	9 cm. H_2O	11 cm. H_2O

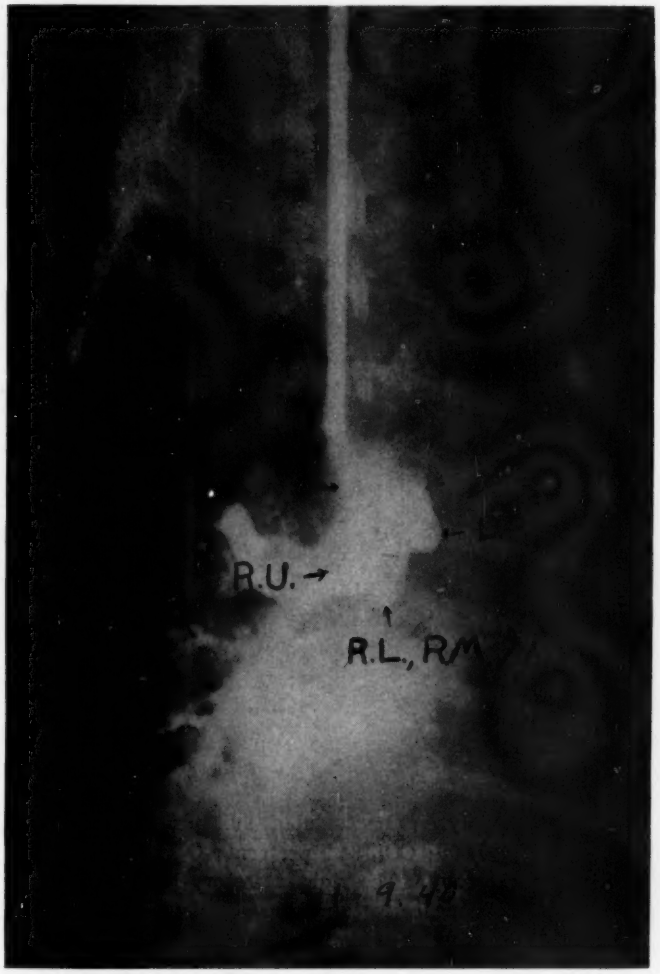


Fig. 4*B*.—X-ray of chest of Dog 748 on Jan. 9, 1940, following iodized oil filling of the bronchial tree. Only the right upper lobe bronchus is open, all others having been closed by silver nitrate cauterization. No pneumothorax remains at this time.

Bronchography (Fig. 4*A*): All bronchi except the right upper and middle were occluded. A pneumothorax on the left side was produced by needle puncture of the right lung.

April 19, 1938. Fluoroscopy and x-ray: The pneumothorax on the left side was completely reabsorbed. The dog was active and healthy. Bronchoscopy showed no change since January 15.

Dec. 6, 1938. Blood analysis: Hemoglobin, 90 per cent; hematocrit, 60 per cent; red blood count, 5,000,000; CO_2, 30.6 per cent; O_2, 17.4 per cent.

Dec. 17, 1938. Bronchoscopy: The right middle lobe bronchus was cauterized with a 35 per cent solution of silver nitrate.

Jan. 21, 1939. The dog was active and apparently normal when at rest. Exercise produced dyspnea. Bronchoscopy showed that the right middle lobe bronchus was occluded.

Jan. 23, 1939. Blood analysis: Hemoglobin, 105.0 per cent; hematocrit, 55.0 per cent; red blood count, 6,400,000; CO_2, 29.2 per cent; O_2, 26.0 per cent.

Jan. 26, 1939: X-ray examination showed no pneumothorax.

April 29, 1939. Fluoroscopy: There was no change since January 26. The dog was active and healthy and became dyspneic only on exertion.

Aug. 12, 1939. Bronchoscopy: Only the right upper lobe bronchus remained unoccluded. This bronchial lumen had increased in size.

Jan. 9, 1940. Bronchography (Fig. 4*B*): The dog was healthy and active over two years following the first collapse of lung tissue.

PROTOCOL OF DOG 24

The lung capacity was reduced subtotally by resection of lung lobes and by bronchial stenosis. The right upper lobe remained inflated.

Oct. 10, 1938: The dog was a healthy appearing male mongrel weighing 12.0 kg. Results of a blood analysis were: Hemoglobin, 95.0 per cent; hematocrit, 57.0 per cent; red blood count, 5,900,000; CO_2, 27.3 per cent; O_2, 13.3 per cent.

Oct. 15, 1938. Blood analysis: Hemoglobin, 97.0 per cent; hematocrit, 55.0 per cent; red blood count, 6,000,000; CO_2, 23.7 per cent; O_2, 25.1 per cent.

Nov. 17, 1938: The left lung was resected.

Dec. 8, 1938. Blood analysis: Hemoglobin, 104 per cent; hematocrit, 64 per cent; red blood count, 8,500,000; CO_2, 27.9 per cent; O_2, 19.1 per cent.

Bronchoscopy: The right lower lobe bronchus was cauterized with a 35 per cent solution of silver nitrate.

Dec. 13, 1938: X-ray of the chest revealed a small pneumothorax persisting in the left costophrenic angle.

Dec. 29, 1938. Blood analysis: Hemoglobin, 115 per cent; hematocrit, 54.0 per cent; red blood count, 6,000,000; CO_2, 29.4 per cent; O_2, 20.8 per cent.

Jan. 27, 1939. Bronchoscopy: The right lower lobe bronchus was completely occluded (probably since Dec. 30, 1938). Cautery was applied to the right middle lobe bronchus.

Feb. 23, 1939. Blood analysis: Hemoglobin, 90.0 per cent; hematocrit, 48.0 per cent; red blood count, 7,500,000; CO_2, 34.9 per cent; O_2, 23.7 per cent.

Feb. 25, 1939. Bronchoscopy: The right accessory lobe bronchus was occluded. Only the right upper lobe bronchus remained open and it had increased in size.

July 29, 1939: Bronchoscopy showed no change since March 18.

Oct. 11, 1939: X-ray of the chest revealed a cardiac shadow adjacent to the left chest wall. No pneumothorax was visible.

Jan. 16, 1940: The dog is active and healthy and becomes dyspneic only on exertion.

DISCUSSION

The dog's ability to tolerate marked reduction of lung capacity appears to be governed largely by the rate at which the diminution is carried out. When the procedure was hastened the animals either died from acute air hunger or from spontaneous pneumothorax. This became particularly obvious after the initial reduction of 43 per cent had been accomplished by left pneumonectomy. Further reduction needed

to be made with caution. Experience has shown a four- to six-week interval to be about the minimum time necessary before further reduction of lung capacity can be tolerated. Further, a reduction at this time of as much as 50 per cent of the remaining lung function was found to be an unsafe procedure (see Dog 617, Table I, and Dog 749, Table II). This principle may be applied clinically in the treatment of bronchiectasis where bilateral operations are necessary to eradicate the disease process. It also demonstrates that high positive pressure anesthesia with face mask or intratracheal catheter is unnecessary in intrathoracic operations since a high reserve of respiratory function is available.[15]

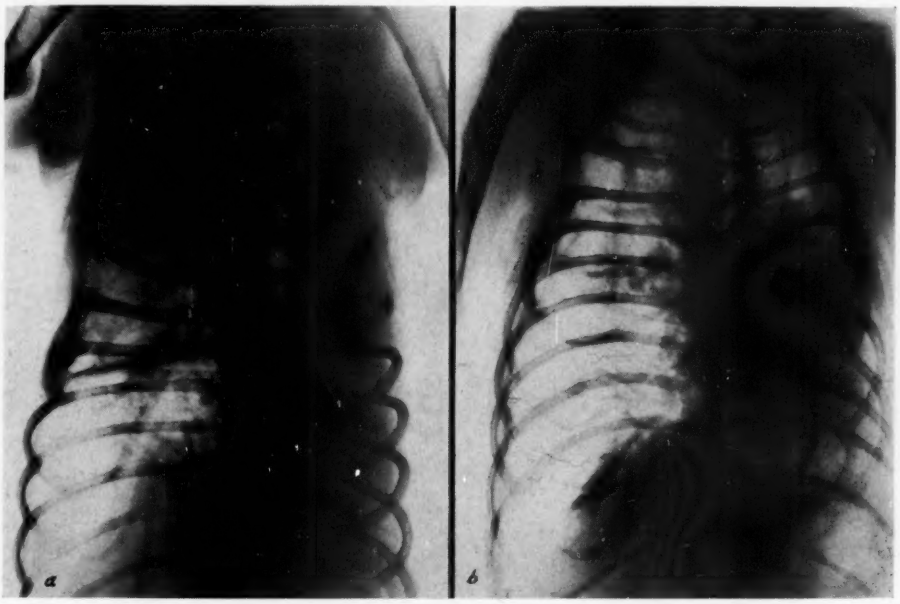


Fig. 5.—Dog 795. *a*, X-ray of chest following left pneumonectomy and right lower and accessory bilobectomy (see Table II). Note opacity in upper half of lung fields. Bronchoscopic examination revealed frank pus exuding from the right upper lung lobe bronchus. The right middle lobe bronchus was clear.
b, X-ray of chest of same dog following resolution of pneumonic process in the right upper lung lobe. Note disappearance of the opacity seen in the previous x-ray.

The immediate increase in hemoglobin and red blood cell count as observed by Andrus and others was substantiated by our experiments. This apparently represents the organism's effort to compensate for the lessened lung capacity. The eventual effect on the organism has not been studied thus far. It is impossible to predict accurately the possible sequelae that may occur to organs as a result of working under persistent oxygen want. The effect on the circulatory and nervous systems, metabolic organs, and kidneys that would follow such persistent anoxia might lead to irreparable retrogressive changes. All dogs apparently compensate early for lung capacity reduction, since the altered blood findings return to an average normal range within a few weeks. The oxygen and carbon dioxide content of the blood changes little.

TABLE I

REDUCTION OF LUNG CAPACITY BY BRONCHIAL STENOSIS WITH ATELECTASIS OF THE CORRESPONDING LOBES IN SEVEN DOGS

DOG	28% LEFT LOWER	15% LEFT UPPER	25% RIGHT LOWER	8.3% RIGHT ACCESSORY	8.7% RIGHT MIDDLE	15% RIGHT UPPER	REDUCTION OF LUNG (%)	RESULTS
748	Collapsed 10/18/37	Collapsed 10/18/37	Collapsed 11/1/37	Collapsed 11/1/37	Collapsed 5/14/39	Inflated	85.0	Living; normal
758	Collapsed 1/11/37	Collapsed 1/11/37	Collapsed 2/19/38	Collapsed 2/19/38	Inflated	Inflated	76.3	*Had worms.* Died 6/27/38; cause unknown
760	Collapsed 10/5/37	Collapsed 10/5/37	Collapsed 11/1/37	Collapsed 4/1/39	Collapsed 11/1/37	Inflated	85.0	Died 6/15/39; cause unknown
617	Collapsed 5/11/31	Inflated	Collapsed 10/29/30	Collapsed 10/29/30	Collapsed 10/29/30	Collapsed 10/29/30	85.0	Died 5/23/31; spontaneous pneumothorax
161	Inflated	Collapsed 4/29/31	Collapsed 3/4/31	Collapsed 6/10/30	Collapsed 4/29/30	Collapsed 6/10/30	72.0	Died 1/9/32; pneumonia, left lower
638	Inflated	Collapsed 12/8/30	Collapsed 5/12/31	Collapsed 6/1/30	Collapsed 5/12/31	Inflated	57.0	Sacrificed 6/15/32; normal
591	Collapsed 10/5/37	Collapsed 5/10/37	Collapsed 10/5/37	Collapsed 11/1/37	Collapsed 11/1/37	Inflated	85.0	Sacrificed 11/15/37; normal

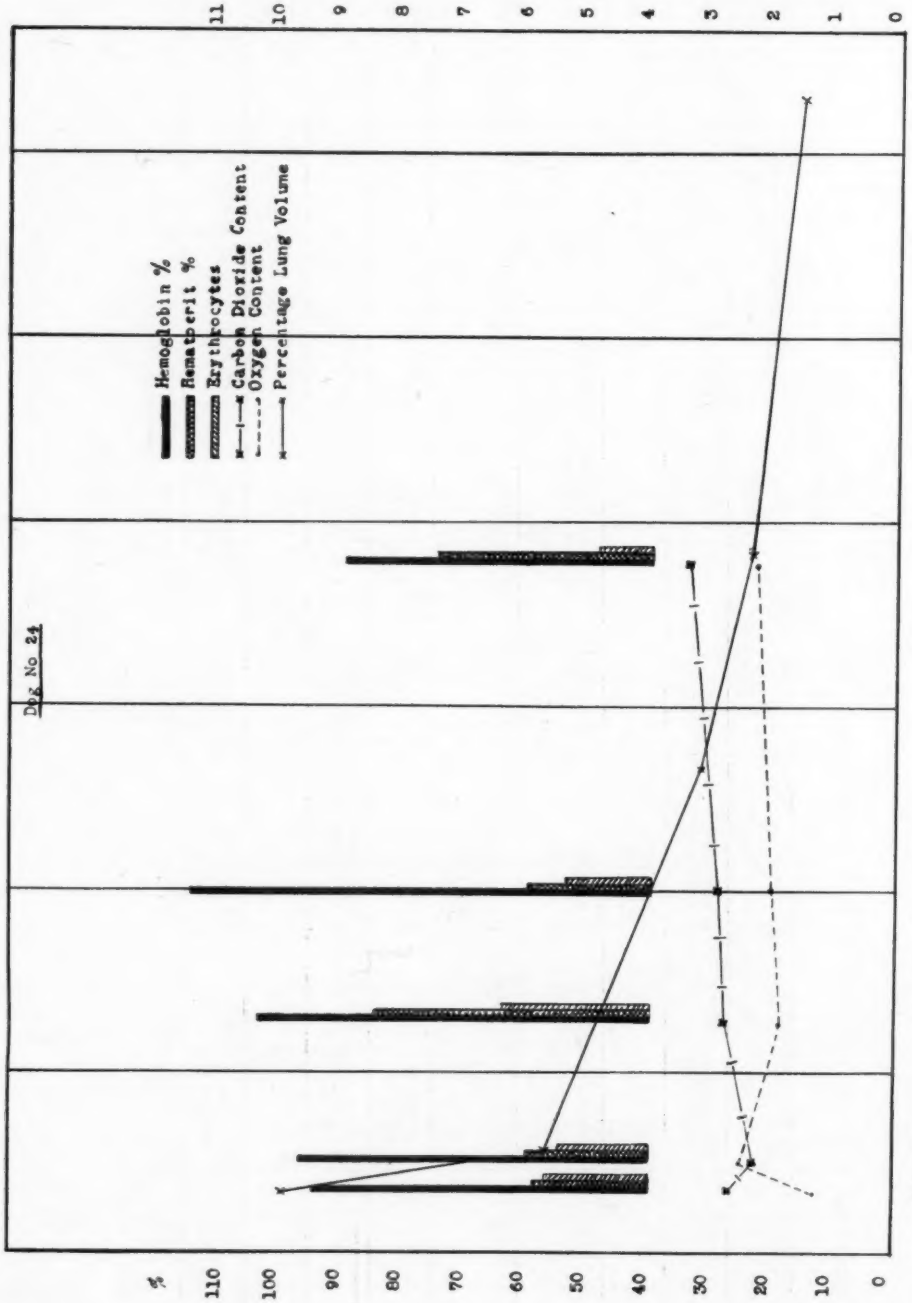
TABLE II

REDUCTION OF LUNG CAPACITY IN PART BY RESECTION AND IN PART BY BRONCHIAL STENOSIS WITH ATELECTASIS OF THE CORRESPONDING LOBES IN NINE DOGS

DOG	28% LEFT LOWER / 15% LEFT UPPER	25% RIGHT LOWER	8.3% RIGHT ACCESSORY	8.7% RIGHT MIDDLE	15% RIGHT UPPER	REDUCTION OF LUNG (%)	RESULTS
87	Pneumonectomy 4/28/38	Collapsed 5/15/37	Collapsed 5/15/37	Collapsed 2/25/39	Inflated	85.0	Living; normal
615	Inflated	Collapsed 10/29/30 Pneumonectomy 2/19/31				43.0	Died 7/27/31; pneumonia, left lung
642	Collapsed 6/5/30 Pneumonectomy 7/1/30	Inflated	Collapsed 10/9/30 Bilobectomy 4/23/31	Collapsed 11/26/30	Inflated	60.0	Sacrificed 7/1/33; normal
795	Collapsed 10/29/30 Pneumonectomy 4/23/31	Collapsed 8/22/30 Bilobectomy 8/26/30	Collapsed 7/15/30	Inflated	Inflated	76.3	Sacrificed 7/1/33; normal
692	Pneumonectomy 9/8/38	Collapsed 12/10/38	Collapsed 2/4/39	Collapsed 3/7/39	Inflated	85.0	Died 3/8/39; spontaneous pneumothorax
24	Pneumonectomy 11/17/38	Collapsed 1/21/39	Collapsed 2/25/39	Collapsed 5/14/39	Inflated	85.0	Living; normal
25	Pneumonectomy 11/16/38	Collapsed 2/4/39	Collapsed 2/25/39	Inflated	Inflated	76.3	Sacrificed 3/18/39; infected chest wall
749	Pneumonectomy 11/11/38	Collapsed 11/4/39	Collapsed 4/1/39	Collapsed 11/4/39	Inflated	85.0	Died 11/6/39; spontaneous pneumothorax
746	Pneumonectomy 9/1/38	Collapsed 12/17/38	Inflated	Collapsed 3/18/38	Inflated	76.7	Died 4/13/39; pyothorax

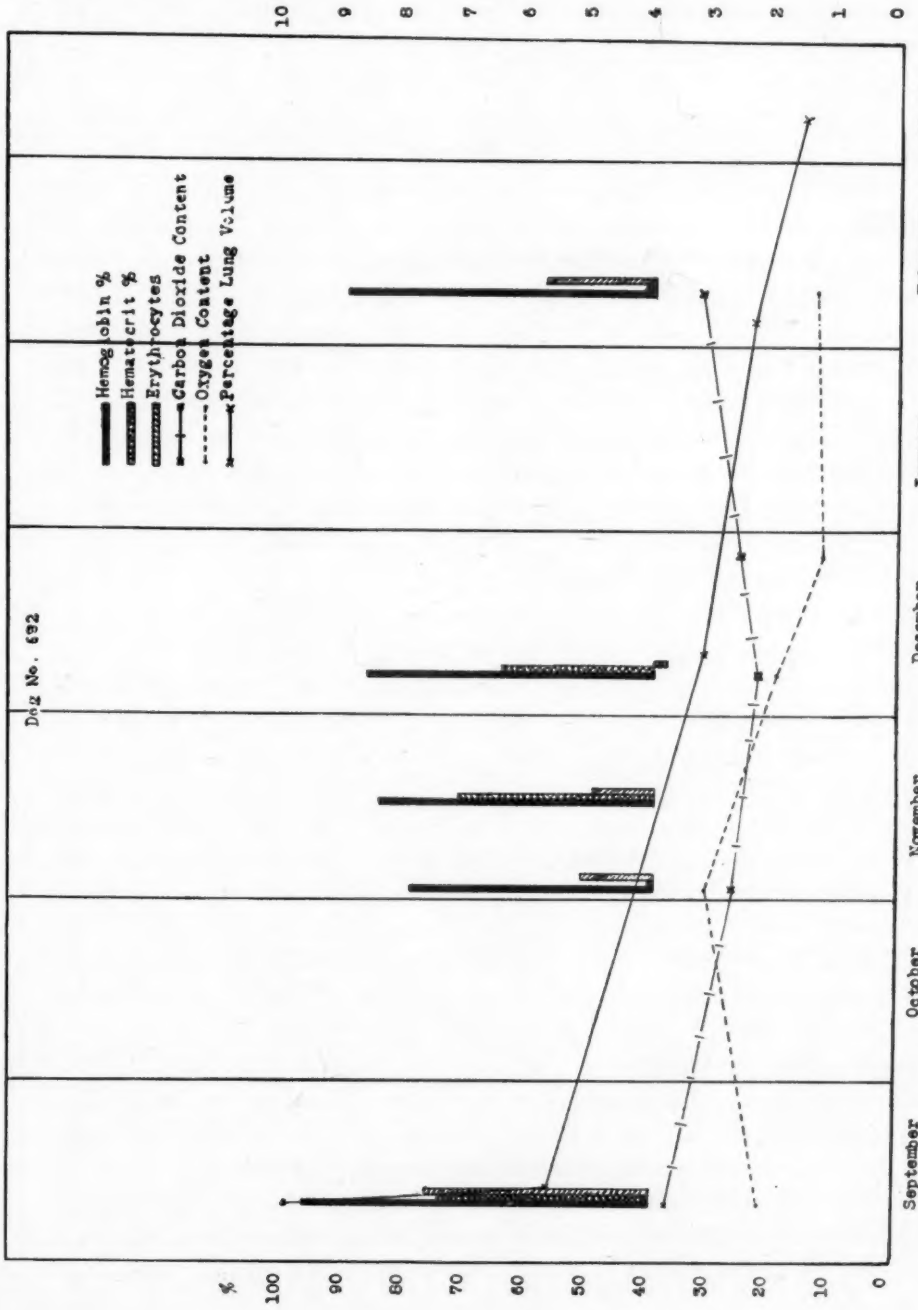
This in itself would seem to indicate that the cellular increase in the blood is a compensatory measure to enhance the faculty of blood gas exchange in a lung of reduced functional capacity.

A marked shift in the mediastinal contents occurs as the lobes of the lung become completely collapsed. Additional and new stresses are put on the supporting structures of the heart and mediastinum. Without adequate time for adjustment to the new relationships, embarrass-



Graph 1.—Graphic presentation of the experimental course of the animal during the diminution of lung volume by surgical resection and chemical stenosis. Note that the blood gas remains within normal limits of variation and that the blood findings eventually approach normal. (See Table II.)

ment to circulation and to cardiac action is likely to transpire. The tolerance of the heart to changes of position varies somewhat with the direction of the shift. Rienhoff and others have found that in man the heart and great vessels tolerate a shift to the left better than in the opposite direction.[16] However, total ablation of the right lung may also result in little or no disturbance of cardiorespiratory function. A rapid change in elevation of the diaphragm may lead to dysfunction



Graph 2.—Note minimal variation in blood findings during diminution of lung volume. This animal developed spontaneous pneumothorax and died one day after lung capacity was decreased to approximately 15 per cent of normal. (See Table II.)

of the abdominal organs.[17] The loss of manipulatory function of the lung lobes on the thoracic veins and the ensuing continuously increased negative intrathoracic pressure may have an undetermined effect upon the return flow of blood to the heart.

When, on massive collapse of the lung lobes, the diaphragm becomes elevated to the maximum degree, either the remaining lobes must overdistend or pneumothorax must follow. Actual experience demonstrates that both frequently occur. The pneumothorax is gradually reabsorbed over a period of a few weeks as the uncollapsed lobes overinflate to fill the space previously occupied by the collapsed lobes. Even in dogs where a marked pneumothorax had persisted for several weeks following lung collapse or resection, little pleural fluid developed and no appreciable pleural thickening was grossly demonstrable. This is most probably due to the ability of the remaining inflated lung tissue to obliterate ultimately all of the pleural space. The intrapleural negative pressure following atelectasis of an entire lung was found to be altered on each side of the chest, but more so on the side of collapse (see protocol of Dog 748). The usual alteration was as follows: on the side of atelectasis, –11 to –14 cm. H_2O; on the uncollapsed side, –9 to –11 cm. H_2O; thus, an increased negative pressure of approximately 3 cm. H_2O, or 50 per cent, on the uncollapsed side, and from 5 to 6 cm. H_2O, or 85 per cent, on the side of atelectasis. This explains why the air is seen on the side of collapse when a spontaneous pneumothorax results from the collapse of one entire lung.[18]

Microscopic sections of the resultant overdistended pulmonary tissue reveal widespread compensatory emphysema. Although the sublethal reduction in lung capacity may be accomplished over a period of several weeks or months, marked stretching and fragmentation of the alveolar walls occur (Fig. 3*B*). This undoubtedly causes a decrease in respiratory efficiency of the lung tissue. As a result of the normal elasticity of lung tissue, a gradual, rather than a rapid, distention is probably more easily tolerated and with less permanent damage to the lung parenchyma. A severe injury to the lung parenchyma would necessarily result in poorer gas exchange. The eventual condition might well be compared to the lungs of a patient with marked silicosis. As a result of this increased load on the circulatory system, acute right heart damage or failure is likely to develop.

The clinical significance of the above findings may be seen in the bilateral extirpation of lung tissue in the treatment of bronchiectasis. Partial obliteration of the residual pleural space following lobectomy may be obtained by paralyzing the diaphragm. In this way overdistention of the remaining pulmonary tissue is reduced to a minimum. Whether the paralysis should be temporary or permanent and whether it should be unilateral or bilateral may be governed by the degree of

involvement, vital capacity, and other factors in each individual case. The importance of this factor will vary indirectly with the amount of atelectasis and shrinkage of the involved lung lobes prior to operation. Experimental work in this regard will appear in a later publication.

CONCLUSIONS

1. Healthy dogs may remain well and active after reduction of volume of normal lung to 15 per cent, thus demonstrating a high degree of respiratory reserve.

2. Reduction of lung capacity is accompanied by a compensatory adjustment of the organs of cardiorespiratory function.

3. Marked compensatory emphysema, with stretching and fragmentation of the alveolar walls, occurs and persists in the remaining overdistended pulmonary tissue.

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CLOSURE AND SUBSEQUENT CARE OF OBSTETRIC AND GYNECOLOGIC ABDOMINAL WOUND DISRUPTIONS

H. Close Hesseltine, M.D., and George P. Bohlender, M.D.,
Chicago, Ill.

(From the Department of Obstetrics and Gynecology, the University of Chicago, and the Chicago Lying-in Hospital)

Williamson[26] estimates 2,500,000 laparotomies are performed annually in the United States. Since evisceration through the postoperative abdominal wound occurs in approximately 0.6 per cent (based upon a combined series of reports[6, 8, 9, 11, 14, 20, 22]), there would be approximately 15,000 such complications yearly. The average mortality is 33 per cent in association with rupture of abdominal wounds, and thus there would be an estimated 5,000 deaths. The actual number of deaths directly attributable to the wound separations alone has not been ascertained, but, if one may assume that it ranges from one-fifth to one-half of the group, then 1,000 to 2,500 people die because of the evisceration. The morbidity and complications in the survivors add further to the gravity of this tragic condition.

The limited amount of literature gives direct and indirect causes of evisceration and offers some means of prevention, but notwithstanding these commendable publications the problem is incompletely solved. Moreover, there is a paucity of information on the care subsequent to eventration. Its infrequency allows only those connected with a large surgical service an opportunity for proper study.

This report deals with the closure and subsequent care of evisceration in obstetric and gynecologic patients, but, since the same therapeutic factors probably prevail in all laparotomy wound disruptions, these methods would seem generally applicable.

A REVIEW OF LITERATURE

Jenkins,[11] at the University of Chicago, in an extensive study on all abdominal eviscerations and on suture material reports 36 cases of evisceration and reviews 1,258 others. Singleton and Blocker[20] have since added 61; Fallis,[6] 49; Glenn and Moore,[8] 22; Whipple and Elliott,[23] 6; Kraissl, Kesten, and Cimiotti,[13] 30; Kross,[14] 44; Hinton,[9] 19; Baer, Reis, and DeCosta,[2] 7; and von Graff,[22] 9. Thus, to date 1,505 cases of dehiscence of abdominal incisions have been reported with an average mortality of approximately 33 per cent.

Jenkins[11] observed an immediate mortality of 18 per cent in a pooled group of 227 obstetric and gynecologic patients. Baer, Reis, and DeCosta[2] had 14 per cent in 7 cases. Horner[10] had no immediate deaths in 3 cases, but 1 patient succumbed at the time of herniotomy two years

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later. Even with the 65.5 per cent death rate in Singleton and Blocker's[20] patients, the pooled data support the contention that the lower abdominal gynecologic and obstetric incisions are associated with a lower mortality in the event of disruption.

Various explanations for evisceration include sudden and undue strain upon the incompletely healed wound, infection in the wound, inadequate hemostasis, abdominal distention, incorrect approximation of tissues, abnormal wound healing, constitutional disorders, and possibly sensitization to suture material.

In 1925 Shipley[19] recommended for the secondary closure a through-and-through silver wire suture with a pack below the wire to protect the viscera and a pack above to keep the edges apart. After a few days, when the wound edges are healthy, both packs are removed; the sutures are then further tightened and a small gauze pack is placed again in the superficial portion of the wound for about ten days more. The skin edges are closed after this pack is removed. Thus, some fifteen to twenty days elapse after the evisceration before the wound is completely closed.

Eliason and McLaughlin[5] recommend packing of the wound and fixation by adhesive tape. The exception to this routine is made only for those in very good condition. Pool[18] uses a Mikulicz tampon when suturing is not feasible. Starr and Nason[21] concur with Pool in the employment of aspiration of the bowel if it cannot be otherwise replaced, while Horner[10] once sutured a rubber dam to the skin edge to protect the protruding viscera.

On the contrary, Bellin,[3] Milbert,[17] Starr and Nason,[21] Bevan,[4] Koster and Kasman,[12] White,[24] Meleney and Howes,[16] and Maes, Boyce, and McFetridge[15] agree ordinarily upon immediate secondary closure and generally subscribe to the use of mass through-and-through sutures of nonabsorbable material. The trend is definitely away from the use of absorbable sutures for the approximation of the peritoneum. Practically all agree upon wound packing and adhesive bandage for the patient in extremis, completing the closure when the patient's condition improves sufficiently.

DATA

On the obstetric and gynecologic services at the University of Chicago Clinics there have been 3,179 (Table I) abdominal operations up to June 30, 1939. The service started in October, 1929, at the Albert Merritt Billings Hospital, and in May, 1931, at the new Chicago Lying-in Hospital. Seven disruptions of the abdominal wound occurred in the 1,370 laparotomies in obstetric patients which gave an incidence of 0.51 (0.510) per cent. In the gynecologic group of 1,809 it occurred 8 times, an incidence of 0.44 (0.442) per cent. The total of 3,179 operations and 15 eviscerations makes the rate 0.47 (0.468) per cent. This is somewhat higher than several report, yet it comes well within the average of range

of the current literature. These patients have been for the most part staff cases (teaching service) and evisceration has occurred on the services of all attending men. The primary closures in all 15 cases of evisceration were made with catgut suture for peritoneum and fascia. Eight had three silkworm gut tension sutures and 1 had two such sutures. The skin edges were closed in 5 with skin clips, in 7 with silk, and in 3 with catgut. Three patients had wound separation with tension sutures in situ. In retrospect it would seem that the small number of supporting nonabsorbable sutures were inadequate.

TABLE I

TYPE OF OBSTETRIC AND GYNECOLOGIC ABDOMINAL OPERATIONS AND INCIDENCE OF EVISCERATIONS*

	NO. OF		
	OPERATIONS	EVISCERATIONS	
		NO.	PER CENT
Obstetric			
Cesarean section	1162	5	
Hysterotomy and hysterectomy (therapeutic abortion)	80	1	
Removal of ruptured uterus	15	0	
Salpingectomy (ectopic)	42	0	
Postpartum abdominal sterilizations	71	1	
Total	1370	7	0.51
Gynecologic			
Adnexal operations	445	4	†
Hysterectomy			
Complete	333	2	‡
Incomplete	821	2	
Myomectomy	46	0	
Exploratory laparotomy	102	0	
Combined laparotomy and plastic	62	0	
Total	1809	8	0.442
Grand Total	3179	15	0.468

*Mortality: immediate and delayed, 13.33%; immediate, 6.66%.
†Died on third day (1 patient).
‡Death after elective herniotomy five months later (1 patient).

The type of primary operations are listed in Table I. Hysterotomy and hysterectomy for therapeutic termination of pregnancy before the period of viability is listed separately from hysterotomy after viability (cesarean section), although there is probably little occasion for such differentiation. The removal of ruptured uteri (post partum) is given special attention because all of these patients had been delivered by the vaginal route and because several had been delivered outside the hospital by other agencies. "Post-partum abdominal sterilization" means that group of patients in which the abdomen was opened in six to thirty hours after vaginal delivery for the ligation of the tubes, a procedure recently reported by Adair and Brown.[1] The one disruption in this subgroup took place in an atelectatic patient who had been placed on "blow bottles." No deaths followed evisceration in the obstetric series.

Adnexal operations include those procedures in which the ovaries, tubes, and/or ligaments were treated. The heading of hysterectomy includes all uteri removed with or without the adnexa. Exploratory lapatoromies include those not under other headings, as freeing intestinal obstruction, biopsy of pelvic structure, and closure without removal of viscera, etc. The combined laparotomy and plastic operations refer to those in which both abdominal and vaginal operations were performed concurrently.

The first of the 2 deaths in the gynecologic series occurred from a generalized peritonitis four days after the secondary closure of the wound. At the primary operation two large ovarian cysts were removed. This patient took a poor anesthesia apparently because of previous injury to the laryngeal nerve during a thyroidectomy and a tracheotomy was performed after the operation to maintain an airway.

Another patient who had recovered from the evisceration returned five months later for an elective repair of the resultant hernia but succumbed eighty-three days later from agranulocytosis and infection. This patient had originally had a total hysterectomy and removal of the adnexa for uterine carcinoma. Between the first and second operations she had a complete series of deep x-ray treatments.

Thus, 2 deaths followed evisceration, one directly and the other indirectly. Whether the second death should be charged entirely to the evisceration may be debated. The immediate and remote mortality rate for these 15 disruptions is 13.3 per cent. The immediate death rate alone becomes 6.6 per cent. These rates are far below the general average of 33 per cent with ranges from 0 per cent (Starr and Nason) in 15 cases to 63 per cent (Glasser) in 8 cases.

All eviscerations are listed in Table II. At the primary operation the first 3 obstetric patients had local and gas anesthesia; the next 3 had local only, while the last (seventh) one had spinal. On the other hand, all of the gynecologic group were given combined ethylene and ether anesthesia. The various contributory factors for evisceration were distention, coughing, vomiting, or other undue stress upon the incompletely healed wound. Six cases had been operated previously. The wide age range, various clinical conditions, and different primary operations exclude single factors as outstandingly important in contributing to evisceration. However, a suprapubic midline incision was used in all these cases.

The first, second, and third obstetric patients and the third, fourth, and sixth gynecologic patients had had previous operations.

Eight of the 15 patients had serosanguineous discharge before disruption, while 7 were without premonitory signs. The dehiscences were recognized promptly and all patients were treated by immediate surgical closure of the wound. Six of the 15 were reclosed by catgut suture layer by layer throughout and in 1 of these wire tension sutures were used. These, with 2 exceptions, were the earlier cases. Two pa-

TABLE II

CONDENSED REPORT OF CASES

UNIT NO.	AGE	PRIMARY		PREMONITORY SIGNS	SECONDARY CLOSURE		
		DIAGNOSIS	OPERATION		METHOD*	ANESTHESIA	RESULTS
Obstetric							
1. No. 133461	20	Contracted pelvis	Laparotrachelotomy, sterilization	Yes	S.W.*	Local	Recovery
2. No. 210892	25	Previous section	Laparotrachelotomy, sterilization	Yes	S.W.	Gas	Recovery
3. No. 79296	30	Contracted pelvis, postoperative hernia	Porro section, herniotomy	No	C.G.	Gas	Recovery
4. No. 141605	33	Multiparity, varicose veins	24 hr. sterilization, left oophorectomy	No	C.G. & S.W.	Morphine & scopolamine	Recovery Herniotomy later
5. No. 84293	34	Contracted pelvis	Laparotrachelotomy	No	S.W.	Local	Recovery? Hernia
6. No. 110050	34	Contracted pelvis, umbilical hernia	Laparotrachelotomy, herniotomy	Unrecorded	S.W.	Gas	Recovery
7. No. 141204	39	Pulmonary tuberculosis (6 weeks pregnant)	Hysterectomy	No	C.G. & W.	Local	Recovery
Gynecologic							
1. No. 38507	21	Ovarian cyst	Oophorectomy, appendectomy, suspension	No	C.G. & S.W.	Gas	Recovery
2. No. 57884	32	Mitral stenosis, anemia, cystocele, rectocele	Supracervical hysterectomy	Yes	C.G.	Gas	Recovery
3. No. 70665	34	Intestinal obstruction (postoperative)	Release of adhesion	Yes	S.W.	Local	Recovery
4. No. 83590	41	Fibromyomas	Total hysterectomy	Yes	S.W.	Gas	Recovery
5. No. 179213	43	Fibromyomas	Salpingo-oophorectomy Supracervical hysterectomy	Yes	S.W.	Gas	Recovery
6. No. 131069	45	Ovarian cyst	Bilateral salpingo-oophorectomy	Yes	C.G.	Local	Death on fourth day
7. No. 76746	49	Fibromyomas	Supracervical hysterectomy	No	C.G.	Gas	Recovery
8. No. 40326	65	Obesity, carcinoma of corpus	Total hysterectomy, bilateral salpingo-oophorectomy	No	C.G.	Gas	Recovery, hernia Died after elective herniotomy

*S.W., Silkworm gut through-and-through looped suture;
C.G., Catgut layer by layer;
C.G. & S.W., Catgut on peritoneum and silkworm gut mass suture;
C.G. & W., Catgut and silver wire.

tients had closure of the peritoneum with absorbable material, while the remaining portion of the broken-down area was reapproximated by silkworm gut sutures. The remaining 7 were treated by mass through-and-through "looped" or partial figure-of-8 suture of silkworm gut. One patient in each of these three types of secondary closures developed a postoperative hernia.

PROCEDURE

It is universally agreed that early recognition of this complication is imperative. Even with a well-organized intern and resident staff the significance of a sudden discharge of serous or sanguineous fluid from the wound may be overlooked. On the other hand many put so much stress upon the importance of this sign that perhaps a word of caution is apropos. Admittedly, careful scrutiny is an excellent policy, but one should not invade the wound unless additional evidence warrants it.

The bowel or omentum is recognized easily in the opened incision, but identification of bowel wall or omental edge through a slight aperture in the skin is more difficult. In the incomplete evisceration superficial tympany within the wound ordinarily indicates the presence of bowel. There may be localization of distress in the wound in connection with symptoms of intestinal obstruction. Some wounds break down relatively asymptomatically and the condition is not discovered until the dressings are removed. Often the patient is aware of a sudden "giving away" or loss of support of the abdominal wall.

When the condition is discovered, the dressings are reapplied without changing and held in place by the adhesive corselette. The patient is told that the edge of the wound has separated slightly and that now is the best time to reapproximate it. Great pains are taken to avoid excitement. The patient is given morphine and scopolamine and is taken in her bed to the operating room when everything is in readiness. The operator again reassures the patient and suggests that perhaps a few "whiffs" or "breaths" of gas will make it easier for her. When the surgical team is scrubbed, gowned, and ready, the anesthetist begins the anesthesia. The proponents of local anesthesia advocate it to safeguard further visceral extrusion; still some would hesitate to use infiltration in the presence of infection. The advantages of gas are that it shortens the time of the closure, enhances relaxation, and permits any necessary manipulation. One patient in this series whose condition was particularly serious relaxed very well with "twilight sleep" alone.

After the patient is well anesthetized, an unscrubbed member of the team removes the adhesive corselette. The skin is prepared with tincture of iodine and alcohol applications: particular care is exercised to keep these solutions from contacting the bowel and omentum. If there is no accentuation of the evisceration, the external sutures may be removed before preparation of the skin; otherwise their removal follows the preparation and draping. Moist warm laparotomy pads may be used to prevent further protrusion. The viscera are freed from the wound

edges only and replaced with the least possible manipulation and exploration. Further intra-abdominal exploration should be avoided as it favors the spread of infections.

In this series the mass "looped" or partial figure-of-8 suture of silkworm gut was employed seven times (Figs. 1 and 2). The only two deaths occurred in those closed secondarily with absorbable suture. Yet from the nature of the cases it is obvious that neither the method nor suture material was a responsible factor in the fatalities.

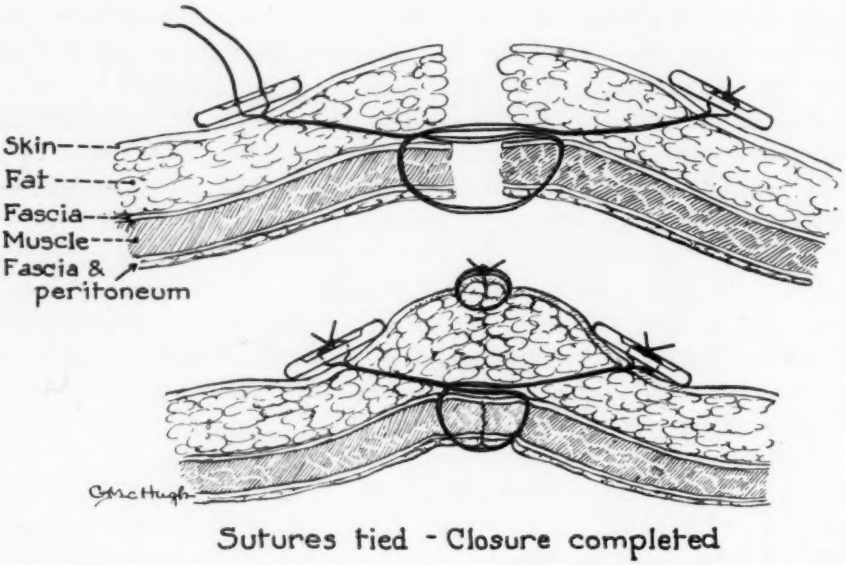

Fig. 1.—Cross section of "loop and a half" mass sutures.

This stitch is a modified figure-of-8, lacking the top of the superficial loop. Without a better designation it is termed a "loop and a half" or a "through-and-through looped" suture. To facilitate understanding of this procedure, it is described as follows. Two strands of silkworm gut are tied over a button. The two free ends are then threaded on a large cutting needle. The suture is started 6 to 7.5 cm. (2½ to 3 inches) from the wound edge and brought out just external to the fascia. It is then carried across the wound to the opposite side, down through the fascia and muscle, and out through the peritoneum near the edge of the wound. (In executing this part the sutures should pierce the healthy fascia some distance lateral to the wound edge.) The needle is then carried back to the original side and carried up through the peritoneum, muscle, and fascia, and thence across the wound and out through fat and skin, ending 6 to 7.5 cm. from the wound on the opposite side. These free ends are then threaded through a button and held until all the sutures are placed. A large number of sutures may be necessary for they should be placed not more than 1.5 to 2.5 cm. (¾ to 1 inch) apart.

If the wound is uninfected and one fears skin contamination, one may place the deep loop first. Under these circumstances the stitch is started in the fascia making the deep loop, coming out through the fascia on the opposite side, and ending by coming out through the skin on the original side of the wound. The other two ends of the suture are then threaded on the needle and brought out through the skin on the opposite side. These free ends are threaded through the button and held.

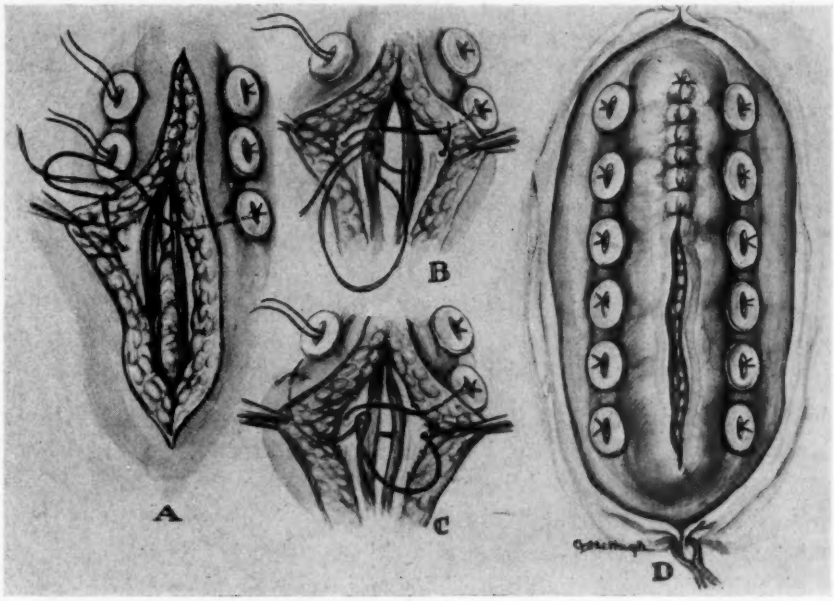

Fig. 2.—Drawing of method of secondary wound closure by "loop and a half" mass sutures.

After all the sutures are placed, steady traction on their free ends closes the wound completely. The greatest care is exercised in closing the wound to keep it free from viscera or omentum and to obtain proper apposition of the layers.

This suture method fulfills the requirements of the generally accepted principles of treatment. Furthermore, one effects a more accurate and correct apposition of the peritoneum, muscle, and fascia respectively than with the usual mass through-and-through suture. Indicated superficial drainage may be easily instituted without disturbing the approximation of the deeper layers.

By proper fixation with the through-and-through "looped" suture the skin edges need only to be brought together. This may be done with silk or skin clips. The usual dry dressings are applied and held firmly in place.

Strict peritonitis therapy is continued for the next three days even in the absence of infection and, if at that time the patient's condition justifies, this management is gradually discontinued. As soon as the

patient has been returned to her room 1,000 to 2,000 c.c. of physiologic sodium chloride or Ringer's solution is given subcutaneously. The amount depends upon the patient's need for fluid and the rate of its absorption. Some six to twelve hours later 1,000 to 1,500 c.c. of 10 per cent glucose is administered intravenously over a period of one to one and one-half hours. Its diuretic action is avoided considerably by its slow administration. At least a total of 3,000 c.c. of Ringer's, Hartman's, or sodium chloride and glucose solutions must be given daily. Five per cent glucose solution may be given subcutaneously but ordinarily only when the intravenous route is contraindicated. Each morning 1,000 to 1,500 c.c. of subcutaneous fluid is administered and then in the afternoon the intravenous solution is started, after which more saline solution may be given subcutaneously. Deviations in the amount of fluids and concentrations of the glucose should be made entirely upon direct indication. This process is repeated daily until the patient's condition becomes favorable for oral administration. The subcutaneous sites are usually the thighs because this location will not interfere with respiration. The rectal route is used seldom because one of the intentions in the therapy is to keep the bowel at rest. Water may be used to moisten the lips and the mouth, but it should not be swallowed.

At the first signs of vomiting or upper abdominal distention gastric siphonage should be instituted by the Wangensteen[25] method. This apparatus, of course, should be watched carefully to insure its proper functioning. The amount of gastric fluid lost is carefully noted and an equal amount of isotonic sodium chloride solution is given to the patient to maintain a chloride balance. The small gastric tube which is passed through one of the nasal cavities may be left in situ for many hours before it is removed. After the patient is rested, it may be inserted again. This process may be repeated as long as necessary. It is important to keep an accurate record of fluid intake and output. Should the patient perspire freely or otherwise lose more fluids than usual, dehydration must be avoided by increasing the amount of parenteral fluids. Distention of the lower bowel may be relieved by the use of rectal tube or glass dumbbell. The patient is kept in a quiet room in Fowler's position and receives special nursing attention. Visitors are restricted to prevent fatiguing and exhausting the patient. Sedatives and analgesics are used freely but judiciously.

One or more transfusions are indicated if there is an anemia. If peritonitis actually occurs, small frequent transfusions may be important, even in the absence of anemia.

Appropriate therapy is instituted for other complications when they arise.

Chemotherapeutic agents, such as sulfanilamide and sulfapyridine, are indicated only when the infectious bacteria are affected bacteriostatically or bactericidally by these medicaments. The value of these prepara-

tions is related directly to their timely and judicious administrations and proper dosage.

If by the end of seventy-two hours absence of evidence of peritonitis persists, as determined by clinical and laboratory means, the patient may be started on clear nonfermenting fluids by mouth. Otherwise the peritonitis therapy is continued until she improves enough to be given oral fluids. Liquids by mouth are given in units of 15 to 30 c.c. (½ to 1 ounce) at fifteen-minute intervals. The amount is increased gradually over the next several hours. The fluids and foods are increased in amount and character as rapidly as the patient tolerates them. Within the next few to several days, the patient arrives back on a maintenance diet. Should evidence of intolerance occur, the diet should be arrested and adequate fluids given parenterally.

The mass sutures are left for ten days or longer, and then only the alternate ones are removed. This is done by raising every other button on one side and cutting the suture. These are more easily removed the following day. A day or so later the process is repeated with the remaining sutures and finally the skin clips or silk is removed.

The success in this therapy of abdominal disruption depends upon early and prompt recognition of the condition, replacement of the viscera without additional soiling of the peritoneal cavity, minimal manipulation, and the adequate administration of the present-day therapy for peritonitis in all cases even in the absence of clinical peritonitis.

SUMMARY AND CONCLUSIONS

If there are 1,000 to 2,500 deaths annually in 15,000 estimated evisceration, certainly the focusing of attention upon this complication is justified. The current literature stresses the causes and prevention of evisceration, yet very little deals with the subsequent treatment. Some of the points in prevention are gentleness in care of tissue, adequate hemostasis, accuracy, and thoroughness in closure of the various layers of the abdominal wall, the intelligent and judicious use of suture materials and the elimination and prevention of undue and sudden stresses as coughing, vomiting, distention, and unreasonable exercise.

When evisceration does occur the following will enhance recovery and reduce morbidity:

1. Early recognition of premonitory signs and actual evisceration.
2. Immediate closure with nonabsorbable mass suture with minimal manipulation.
3. Employment of wound pack only for the very critically ill.
4. Drainage only on positive indications.
5. Strict peritonitis care.

The employment of through-and-through "looped" or "loop and one-half" mass nonabsorbable suture is recommended for closure of evisceration. This method, along with strict medical management for potential or actual peritonitis, has, in this limited series, yielded good results. It

is in agreement with and amplifies recent reports. It does not interfere with drainage of the superficial portion of the wound and drainage from the peritoneal cavity can be instituted by the proper placement of the sutures. At the same time this approximation of tissues gives full vision to the wound edges and appears to give better apposition of the peritoneum, muscle, and fascia respectively than the usual through-and-through mass suture. Current reports advise against the employment of absorbable suture material in secondary closures.

Surely this type of closure has been used by others, but thus far not one report has been found under titles referable to abdominal wound disruptions.

Acknowledgment is made to Dr. Fred L. Adair and the various members of his staff for their cooperation in this study.

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EXPERIMENTAL STUDIES WITH SYNTHETIC FIBER (NYLON*) AS A BURIED SUTURE

LEON J. ARIES, M.D., PH.D., CHICAGO, ILL.

(From the Division of Surgery, Northwestern University Medical School)

SUTURE material has presented a problem to surgeons ever since its inception. The use of nonabsorbable suture has given way to the absorbable suture and again the use of nonabsorbable material is becoming popular. Suture material must approximate tissues and keep them in the desired position until they have united. The suture should not introduce infection or cause irritation in the tissues in which it is used. Since nonabsorbable material is encapsulated and walled-off as a foreign body, the smaller the diameter of the material used, the less will be the tissue response and the greater the ease in encapsulating it. Thus, a fine nonabsorbable suture with a tensile strength greater than an absorbable suture (of even wider diameter) would be advantageous.

Catgut is known to be irritating to the tissues,[1] calling forth an early leucocytic response. Chromicized catgut is less irritating than nonchromicized gut and silk causes even less irritation than any type of catgut. The tensile strength of silk is greater than that of catgut of equal diameter. Silk allows tissue fluids and serum to penetrate between its twisted strands which is followed by an infiltration of leucocytes and granulations within the interstices of the fibers and is followed by an invasion of fibroblasts. Silk treated to prevent this penetration is more irritating to the tissue and is rather stiff and wiry unless soaked before using. When wet, it is more difficult to handle and gnarls or twists into knots. Much of the elasticity of the silk is also lost in this treating process.

We wish to present the results of investigative work on a new synthetic fiber which has practically none of the disadvantages of catgut and has several improvements over silk.

Nylon[2] is a fiber material composed of a synthetic polymer derived from the chemical union of a diprimary diamine and a dicarboxylic acid. It is a chemically inert substance and will thus withstand repeated steam and chemical sterilizations without deterioration. The suture is insensitive to aqueous solutions, except strong acids. The x-ray diffraction pattern has placed this filament in the class of true fibers. Being a synthetic chemical fiber, the material is not subject to inherent bacterial contamination as are sutures derived from tissues of animals or living organisms.

The suture is made in various sizes from No. 000 to No. 2 twisted and from No. 000 to No. 2 braided. The monolithic strand comes in

*The materials used in these experiments were furnished by Curity Laboratories of the Lewis Mfg. Co., Walpole, Mass.

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sizes Nos. 000 to 2, but it is not as flexible as the multifilament strand. Monolithic strand threaded on a needle forms a large loop over the eye, thus cutting holes when drawn through the tissues. The swedged needle has obviated this difficulty, but the suture material still cuts through when approximating soft, delicate tissues. The twisted strand has a greater tensile strength than an equal-sized strand of silk and is easier to handle for the following reasons: The end does not fray readily when cut and can be threaded with ease; when wet it does not snag or twist into knots, even with the No. 000 gauge; there is an ease in approximating tissues without breaking the suture because of its elasticity which also prevents slipping of the knots, and a very small space is occupied by three knots.

PURPOSE OF EXPERIMENT

The following experiments were performed on dogs using nylon and silk to determine the tissue response, the irritative phenomena, the ability of the material to hold under tension, foreign body reaction in delayed healing by the introduction of infection, and the tendency of the material to form fistulous tracts.

Eighteen fascial experiments were carried out on nine dogs. Left and right 4-inch paramedian abdominal incisions were made in the skin of each dog. The anterior rectus sheath was incised for 1 inch at the upper and lower ends of the incision, leaving a 2-inch intact anterior rectus sheath. The upper right rectus muscle and fascial sheath were sutured with No. 000 monolithic undyed nylon, the lower right muscle and fascia with No. 000 twisted nylon. The left abdominal incision was made in the same manner, but the upper right rectus muscle and fascia were sutured with No. 000 undyed silk while in the lower rectus muscle and fascia, black silk was inserted.

Dogs were sacrificed at intervals of from fourteen to sixty-one days. The following gross findings were evident: The monolithic nylon, whether dyed or undyed, presented no adhesions to the overlying subcutaneous tissue. There was no collection of serum and the suture material was more flexible than when placed in the fascia. The material retained its shape and color and was not fragmented. The variation in time from twenty-eight to sixty-one days made very little difference in the gross appearance of the nylon, whether dyed or undyed. The encapsulation of the silk was more complete so that little or no silk was visible. Even the knots were covered with dense tissue. The animals sacrificed at the end of seven to eight weeks were so well healed that it was only the markers left in the tissue that helped reveal the presence of the nylon and silk.

Microscopic sections through the monolithic sutures revealed the material to be well encapsulated. There were a few lymphocytes about the suture in the fourteen-day animals and round cells in the twenty-

eight-day animals. Those sacrificed after fifty-six days presented no infiltration and a definite ring of fibroblasts walling off the suture (Fig. 1).

Microscopic sections of twisted nylon presented a few leucocytes about the suture. The twenty-eight-day animals had lymphocytes in some sections. Later examinations of the nylon revealed the material well walled off from the tissue with no reaction about it.

Microscopic study of the dyed and undyed silk revealed a tissue reaction not appreciated on gross examination. The silk in the fascia and muscle was infiltrated by leucocytes and surrounded by a cuff of leucocytes. The tissue of animals sacrificed after thirty-five to fifty-six days presented fewer cells about the silk and they were lymphocytes and plasma cells in place of the early leucocytic response. In one field the silk and nylon were lying within 15 mm. of each other, the nylon

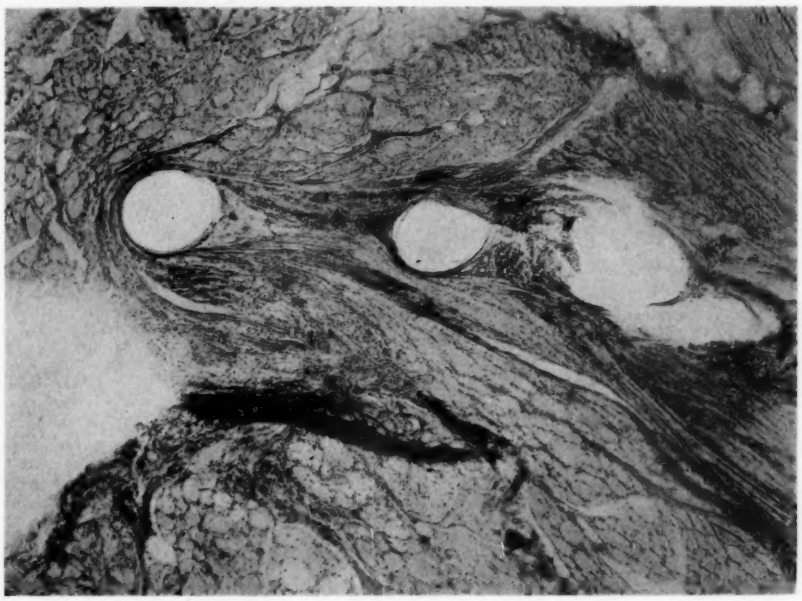

Fig. 1.—Photomicrograph of cross section of rectus muscle in which monolithic No. 000 nylon was allowed to remain for fifty-six days. There are two homogeneous segments of suture visible in the tissue surrounded by connective tissue and a few lymphocytes. (×57.)

free of cells and the silk infiltrated with round cells. Sections of nylon of larger diameter, No. 0, had lymphocytes and round cells in very small numbers between the fibers of the twisted filament. This was less in amount than that caused by the silk.

Twisted nylon, No. 000, is the easiest size to handle and causes less irritation than the same size silk. It is a little more irritating than monolithic nylon, however. Monolithic nylon is not as flexible as the twisted fiber, and thus forms large knots which are not well encapsulated by the tissues.

Three-inch segments of the jejunum and ileum of seven dogs were attached to the anterior parietal peritoneum with No. 000 monolithic nylon swedged on needles to determine whether or not the bowel would cut away from the peritoneal attachment. The suture material had to be swedged on needles to prevent the formation of large holes in the seromuscular layer of the bowel when the monolithic suture looped in a large arc through the eye of the needle. Because of the poor flexibility of the suture, it would partially cut through the bowel wall when an attempt was made to approximate the bowel to the parietal peritoneum. The use of No. 000 multifilament nylon allowed for the use of fine-eyed needles and the accurate approximation of tissues without the suture material looping out between the sutures as in the monolithic strands.

Examination of the fixed loops of bowel at intervals up to sixty days revealed incomplete approximation of the bowel to the peritoneum of the abdominal wall where monolithic strands had been used. A thin, shiny mesothelial layer covered the projecting loops of suture. The bowel sutured with multifilament nylon was well approximated and no suture material was visible. The peritoneum did not reveal irritation and on cross section the material was well encapsulated. Microscopic examination of the peritoneum and bowel wall revealed the suture with a few round cells about the area, not enough to form a single layered cuff about the periphery of the suture material.

Five end-to-end anastomoses were performed on the jejunum and ileum of five dogs using No. 000 nylon sutures. The vessels in the mesentery were ligated separately for study of the effective obliteration of vessels. The usual continuous suture was placed through the full thickness of the bowel using a Connell suture on the anterior surface. A second layer of continuous Lembert suture was inserted in the serosa which approximated easily. No suture material was visible about the anastomosis. The animals were allowed fluid by mouth after six hours if they would take it, and most dogs drank freely the following day. Examination of the anastomoses at intervals from fifteen to sixty-one days did not reveal any evidence of leakage or peritonitis in any of the dogs. It was difficult to find the anastomosis after the fifth week as the suture line was so well approximated. Upon opening into the lumen, the mucosa was smooth and the suture line was not discernible. There was no evidence of the knots of suture material.

Sections of tissue from the wall of the jejunum and ileum revealed the mucosa to be well approximated, the suture material in place and no evidence of serum about it. Microscopic study of the suture in the mucosa indicated an increase in the number of round cells normally present in the mucosa, but no collar of leucocytes about the suture, as was evident with catgut. The suture in the submucous layer (Fig. 2) was surrounded by fibroblasts and connective tissue and was free of invading round cells or leucocytes in twenty-eight-day sections. The

suture in the serosal layer was surrounded by a few cells and only occasionally was there an infiltration of the interstices of the suture filament. Two anastomoses high in the jejunum presented practically no tissue reaction on microscopic study. It is well to note here that anastomoses made by continuous suture using a nonabsorbable suture material are dangerous. The lumen of the bowel cannot dilate due to the limited elasticity of the suture and will continue to contract with healing and scarring, thus narrowing the stoma. Since this material does not fragment or weaken, one should use interrupted stitches to allow dilation of the lumen.

Microscopic examination of the blood vessels in the mesentery tied with nylon revealed complete obliteration of the artery and vein with no evidence of leucocytic or lymphocytic infiltration about the suture material. There was no evidence of the suture having cut through the tissue.

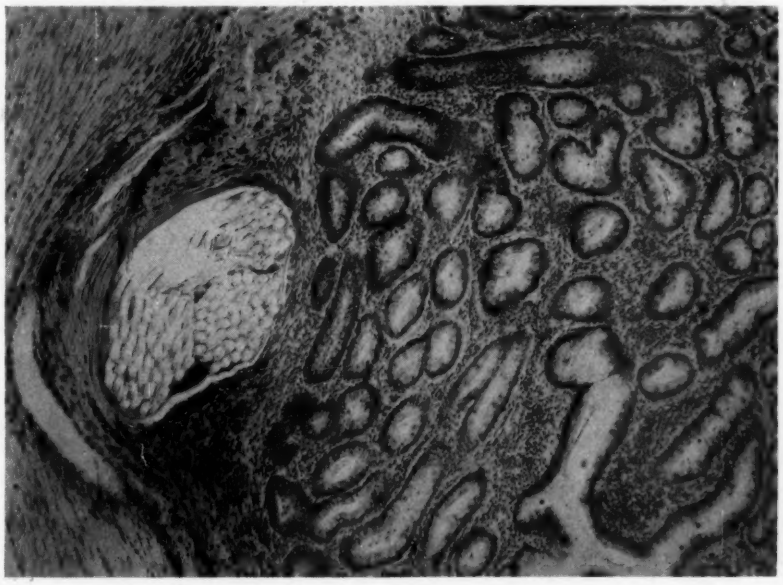

Fig. 2.—Photomicrograph of a cross section of segment of jejunum in which an end-to-end anastomosis had been performed twenty-eight days before using No. 000 twisted nylon suture. Note the absence of cells between the interstices of the twisted strand. (×100.)

The following experiments were performed on the stomach: A longitudinal incision was made through the anterior surface of the stomach 3 inches long; the proximal one-half of the gastrotomy was sutured with twisted black silk and the distal half with nylon, No. 000. Two layers of interrupted suture were used, followed by a peritonealizing layer of silk and nylon, respectively. The animals were examined in fourteen, twenty-one, and twenty-eight days. The incisions were healed. There was no evidence of cutting through the tissues and the mucosa was smooth and intact. Grossly, one could not differentiate the type of suture used, but on microscopic examination the silk suture was

invaded and surrounded by a cuff of round cells. There were a few round cells about the nylon suture, but no cells in the interstices of the fiber (Fig. 3). The lack of reacting cells is striking as grossly the silk and nylon appeared identical.

Two gastroenterostomies were performed in the routine manner using continuous suture of No. 000 nylon. No suture was visible at the completion of the operations. Animals were given fluids after six hours and fed after forty-eight hours. Examination of the anastomoses after twenty-one and twenty-eight days revealed a good functioning enterostomy without adhesions. The size of the stoma was limited by the continuous suture which could not be dilated. The microscopic sections revealed a few round cells about the suture but less irritation than was present in the experimental animals in which silk was used.

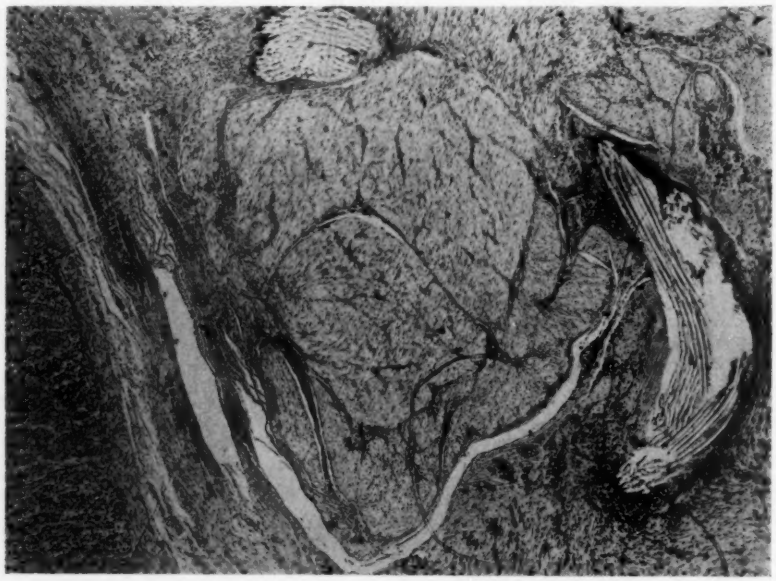

Fig. 3.—Photomicrograph of a segment of stomach in which a gastrotomy had been performed twenty-one days before the upper cross section of No. 000 nylon revealed the presence of a few invading cells. The crescentic longitudinal segment of silk No. 00 on the right is invaded and surrounded by lymphocytes. (×45.)

The sigmoid colon of two dogs was brought up to the abdominal wall and sutured with interrupted No. 000 nylon as a colostomy. Interrupted sutures were placed between the bowel and peritoneum, second between the bowel and fascia, and then between the bowel and skin. The sutures were deliberately placed through the full thickness of the sigmoid to try to form fistulous tracts. The bowel was not opened so that if fistulas developed they could be easily found. Examination of the wound revealed puffiness and edema about the skin margins which subsided after fourteen days. The sutures cut through the skin margins in several places where the tension was great. After twenty-one days the inflammation subsided and the wound appeared pink. The dogs were sacrificed at twenty-eight days. The skin sutures remaining

in position presented areas of inflammation which on microscopic examination were found to be surrounded by cuffs of leucocytes six to eight rows deep. The areas where the sutures had fallen out were being invaded by fibrous tissue. Sutures in the fascia and peritoneum were well encapsulated with no evidence of leakage or fistula formation about the exposed bowel. Microscopic examination of the fascial and peritoneal attachments presented a slight round-cell infiltration about the suture but no infiltration between the fibers. The suture through the mucosa was surrounded by the normal number of round cells of the mucosa.

The following experiments were performed on the bladders of two dogs to determine fistula formation with No. 000 nylon. Through a paramedian incision in the male dog, the urinary bladder was brought up to the anterior abdominal wall. A 1-inch incision was made in the fundus of the bladder and urine escaped. The defect was sutured with two layers of interrupted No. 000 nylon and followed by a continuous suture in the serosa. The bladder was then anchored to the abdominal wound with stay sutures. The peritoneum, fascia, and skin were sutured to the wall of the bladder respectively. The wound became edematous and pink, but this subsided after ten days. The animals were sacrificed after fourteen to twenty-one days. No pus was present in the wound. There was no evidence of fistulas when the bladder was injected with colored fluid under pressure. The bladder was well healed. The serosal surface was adherent to the abdominal scar and the mucosa covered the suture line within the bladder so that it was found only by the serosal markings. Microscopic examination through the suture line to the abdominal wall revealed the suture surrounded by a single layer of cells in the fascia and scattered round cells in the subserosa of the bladder. The areas with leucocytes in the fascia were well surrounded by fibrous tissue and securely walled off. There were no invading cells in the mucosa of the bladder. The suture remained unchanged (Fig. 4).

To determine the fate of silk and nylon in infected wounds, right and left longitudinal paramedian incisions were made through the skin, anterior rectus sheath, and rectus muscle. Into the upper half of each rectus muscle four interrupted nylon sutures were placed and into the lower half of each rectus muscle No. 000 silk was inserted. The fascia was closed with interrupted nylon in the upper half and No. 000 silk in the lower. The wound on the left was inoculated with a pure broth culture of *Bacillus coli* and the right wound with a pure broth culture of *Staphylococcus aureus*. The skin was closed with No. 000 nylon.

Examination of the left wound in three dogs revealed a marked infection with edema and redness of the edges and the presence of frank pus appearing through the skin suture holes. The right wound was edematous and red; little pus was present. After fourteen days the inflammation in the left wound began to subside and the pus was less in

amount. Edema of the edges was still marked. The nylon suture had cut through in two places. The right wound was pink and slight edema was present. The nylon suture was absent from two sutured areas. After twenty-one days the wound on the left was free of pus, but a serous discharge persisted from the suture holes. There were no gaps in the wound, but serum caused an elevation of the skin. The right wound was well healed. The dogs were sacrificed at twenty-four days and the skin opened through the original incisions. The right fascia held securely in the silk and nylon ties; however, the fascia retracted between the sutures. Grossly the silk and nylon appeared the same. The left fascia and muscle were covered by a mucoid material and the sutures were lying securely knotted in the fascia, the edges of which were retracting. Microscopic examination of the left and right fascia and muscle presented a marked infiltration with leucocytes about the silk

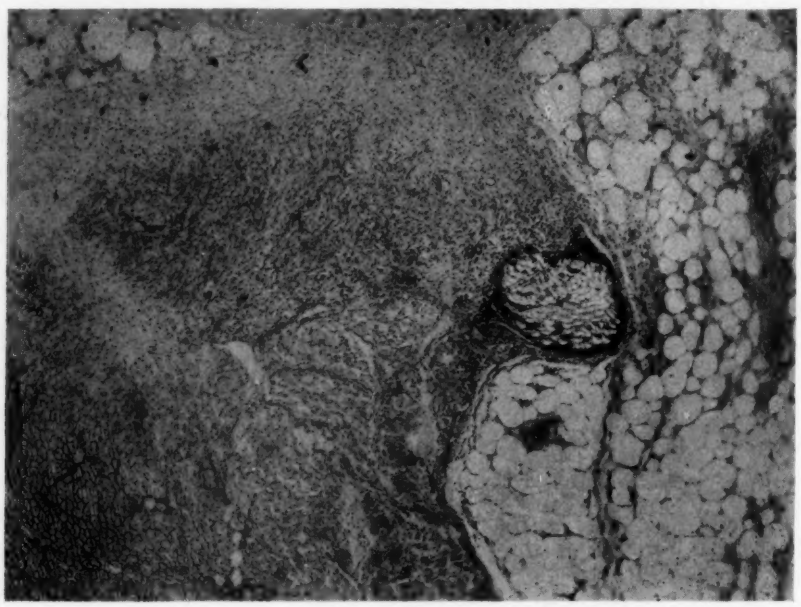

Fig. 4.—Photomicrograph of section of bladder in which No. 000 nylon was used to close the cystotomy. There is evidence of presence of round cells about the suture. (×50.)

and in between its fibers. There was marked separation of the fibers with a fragmentation of the silk. The nylon was surrounded by cuffs of leucocytes and lymphocytes which are not as closely packed together as about the silk suture. At this period, of twenty-four days, the infection seemed to be in a less acute stage about the nylon with a shift to lymphocytes, while leucocytes still surrounded the silk.

Use of Nylon in Perineurium.—The sciatic nerves of three dogs were exposed and only partially severed to prevent a complete paralysis which is usually followed by infection in the wound. The perineurium was sutured with No. 000 nylon which brought the nerve ends together. No attempt was made to cover the sutured areas with fat, but the nerve was

dropped back into its original position. Examination after three and four weeks revealed adhesions present about the suture line which were easily freed. The suture was well covered with fibrous tissue. On cross section the suture was visualized about the nerve bundles. On microscopic examination there were no leucocytes present in the perineurium or between nerve bundles. There were fibroblasts present about the nylon suture and occasional lymphocytes.

The extensor tendons of the forelegs of three dogs were exposed by a longitudinal incision and the tendon sheaths incised. Three tendons of the foreleg of each dog were severed transversely and immediately repaired, two of the tendons with nylon suture and one with silk in each dog. The sutures were placed through the tendon about one-half inch proximal to the severed end and tied to the tendon edge forming long tension sutures which were then tied to each other across the gap. Two

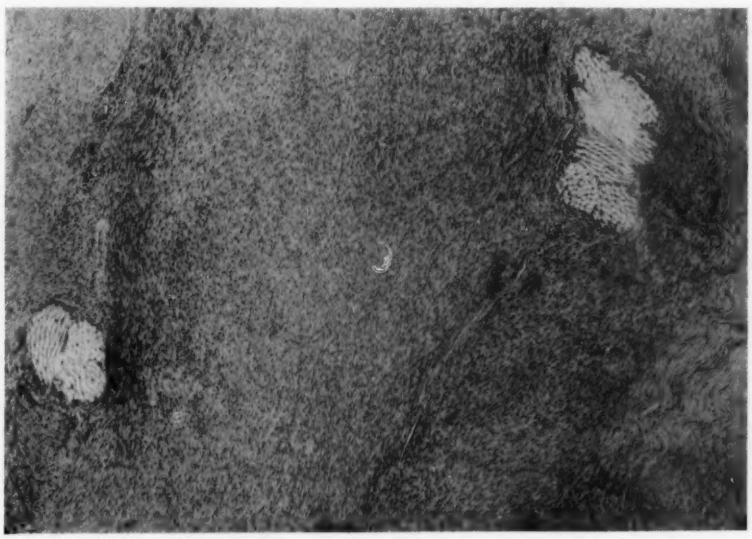

Fig. 5.—Photomicrographs of an end-to-end anastomosis of extensor tendon twenty-eight days. No. 000 nylon suture appears in the tendon without evidence of infiltration of white cells. (×45.)

interrupted sutures were placed through the severed ends to approximate the cut surfaces. The superficial fascia and skin were closed with nylon. The forelegs were then encased in plaster of Paris casts from humerus to phalanges and allowed to remain for two, three, and four weeks, when segments of the tendons were removed and the dogs used for other suture experiments.

Examination of the tendons after two weeks revealed practically the same findings in all tendons whether silk or nylon was used. There was a thickening of the suture line at the end of two weeks which diminished in bulk at the third week; and at the end of four weeks there was practically no thickening so that it was difficult to find the suture material except for the marker. The microscopic examination of the nylon is demonstrated in Fig. 5. There were no round cells or

leucocytes but a few plasma cells and fibroblasts surrounding the suture material. The microscopic sections of the tendon with silk revealed the presence of three rows of lymphocytes and leucocytes surrounding the silk, a definite irritation as compared with nylon.

SUMMARY AND CONCLUSIONS

Experiments performed with nylon suture in fascia and muscle reveal the use of monolithic suture to be superior to twisted nylon and silk, causing less irritation to, and being the least affected by, the tissues. Monolithic strands, however, are more difficult to handle, are not as flexible as the twisted filaments, and are thus less practical for deep suture of abdominal viscera. The knots are bulky and not easily encapsulated.

Multifilament nylon, especially No. 000, is easily handled, is flexible, and can be threaded without difficulty on fine needles. This suture approximates tissues without cutting through. The material is more elastic than silk and in the fascia and muscle does not cause as much irritation to and is not attacked by, the white blood corpuscles, as acutely as a similar-sized silk suture.

Experiments performed on stomach, jejunum, and ileum show excellent results with nylon as to its lack of irritative properties and good retentive ability, even with such small caliber material as the No. 000 gauge.

The use of nylon in attaching hollow organs to the abdominal wall as the sigmoid colon and the bladder does not result in fistulous tracts, while the viscus remains securely attached to the wound.

Bladder tears closed with No. 000 nylon hold securely and do not result in fistulous tracts.

Nylon placed in tendon and nerve is well tolerated, does not call forth a leucocytic or even lymphocytic response. The fine-sized No. 000 suture will hold the tendon securely and does not occupy much space.

Nylon in infected wounds acts much the same as silk in securely holding the tissues and remaining unchanged. Nylon allows for an early change from leucocytic to lymphocytic response about the suture, while the silk keeps the leucocytes present for longer periods.

Nylon has all the good qualities of silk and in addition is stronger, less irritating, and does not allow for as marked an invasion of its interstices as silk.

Nylon may be boiled several times without losing its original tensile strength.

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HOW LONG SHOULD OPERATION BE DEFERRED IN CASES OF INTENSE JAUNDICE OF RECENT ONSET?

ARTHUR L. BLOOMFIELD, M.D., SAN FRANCISCO, CALIF.
(From the Department of Medicine, Stanford University School of Medicine)

WHILE the majority of cases of intense jaundice are due to hepatitis,* stone in the common duct, or cancer implicating the bile passages, the differential diagnosis of these three conditions is often extraordinarily difficult. Stone and cancer are, of course, unusual in young people; previous attacks of colic point to stone and the demonstration of a huge distended gall bladder or metastatic nodules practically clinches the diagnosis of neoplasm, but all signs can fail, including the various laboratory tests, and one may observe the patient day after day without reaching a definite conclusion. This group of undiagnosable cases of intense acute jaundice is a sore trial to the physician, particularly with reference to surgical interference. If the patient has stone in the common duct, operation is, of course, in order, and if an attempt is to be made to do anything about cancer, then the sooner the better. But if the jaundice is due to hepatitis, one is dealing with a nonsurgical condition and exploration not only serves no purpose but may harm the patient. In a recent case, for example, an elderly man, intense jaundice with acholic stools had existed for three weeks without definite diagnosis being possible. He was in splendid condition and seemed to tolerate his icterus unusually well. At operation there was found not the suspected stone but hepatitis with colorless material in the ducts and in the gall bladder, which was drained. In spite of thorough preparation with glucose and saline solution, bile salts, and vitamin K, the patient lapsed into coma with high blood urea and fever and died within three days.

It has been our impression that surgeons faced with this problem of intense jaundice of uncertain cause have no very definite basis for deciding just when interference is in order, if at all. What happens as a rule is that after a variable and irrational period of observation those in attendance feel they have waited "long enough" and that they had better "look in." They have not clearly formulated the problem in some such way as this: It is desirable to operate for stone or cancer, but undesirable to operate because of hepatitis. Since hepatitis usually clears up spontaneously, how long should one wait for such clearing in a doubtful case of intense jaundice before concluding that one is not dealing with hepatitis and that operation is therefore in order?

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*In this paper hepatitis is used to include what is commonly spoken of as catarrhal or acute infectious jaundice.

As a background with which to compare the statistics to be discussed presently, the above question was posed to five surgeons, all senior staff men of large experience, and to five internists. The surgeons gave it as their opinion that with intense obscure jaundice of recent onset one should not delay operation for over one week (one opinion), ten days (two opinions) and two to three weeks (two opinions). Walters and Snell[1] in their recent monograph concur in the feeling that only a brief period of watching is justifiable. The internists, on the other hand, apparently aware of rare instances of acute hepatitis that clear up entirely after several months of jaundice, all felt one should wait from four to eight weeks.

In view of all this confusion it seemed important to get the facts as to how soon the jaundice begins to lessen. A search through our files yielded twenty-nine cases, proved by their subsequent course to have simple hepatitis, in which it was possible to determine with reasonable accuracy the number of days from onset of jaundice to the beginning of subsidence. The trend of the van den Bergh test or of the icterus index measured at frequent intervals together with the presence or absence of bile in the stools were the pertinent data. Table I is a

TABLE I

DATA FOR CALCULATION OF DURATION OF JAUNDICE FROM ONSET UNTIL CLEARING BEGAN IN PATIENT F*

	VAN DEN BERGH (UNITS)	ICTERIC INDEX (UNITS)	BILE IN STOOLS
July 1, 1936, jaundice first noticed			
July 16	50	208	
July 22	50	178	
July 27	45	182	0
Aug. 3	45	166	0
Aug. 8	27	150	+
Aug. 10	--	---	+++
Aug. 15	24	92	
Aug. 22	--	60	

*Onset of resolution of jaundice is clearly not earlier than Aug. 3 nor later than Aug. 8. The total duration of the jaundice until clearing began is then not less than thirty-four days and not over thirty-nine days.

protocol of an illustrative case, and Table II gives a summary of all the observations. Table III is of special importance because it shows how soon jaundice begins to subside in various cases of hepatitis. It is seen, for example, that after two weeks only 28 per cent of the cases had begun to clear. Obviously, then, the surgeon who interferes after so short a period of observation will operate ill advisedly on many people who would later recover spontaneously. Even three weeks is too brief a time and in order to be sure that one is not dealing with a spontaneously resolvable icterus one should wait in doubtful cases for at least four and perhaps five weeks. No harm will be done, even if stone or cancer turns out to be present, by a delay of this duration, especially now that a hemorrhagic tendency can be controlled by vitamin K and bile salts.

TABLE II

SUMMARY OF OBSERVATIONS OF DURATION OF JAUNDICE IN CASES OF HEPATITIS BEFORE CLEARING BEGAN

CASE NO.	AGE	SEX	DURATION OF JAUNDICE UNTIL CLEARING BEGAN* (DAYS)	HIGHEST VAN DEN BERGH (UNITS)	HIGHEST ICTERIC INDEX (UNITS)
1	8	F	6	--	---
2	48	F	6	10	53
3	30	M	7	11	54
4	12	M	7	--	---
5	26	F	7	--	83
6	34	M	9	18	66
7	43	M	10	8	50
8	35	M	10	15	---
9	58	F	14	60	200
10	44	M	14	13	68
11	40	M	16	40	129
12	38	M	17	12	---
13	38	M	18	--	33
14	34	M	18	24	65
15	45	F	21	60	166
16	67	M	21	49	144
17	67	M	21	--	160
18	25	M	21	6	34
19	31	M	21	50	166
20	50	M	21	56	256
21	49	F	21	--	50
22	50	F	23	35	144
23	35	M	23	8	62
24	48	M	26	110	300
25	38	M	30	15	75
26	37	M	30	5	33
27	53	M	35	8	50
28	68	M	35	25	100
29	22	M	35	50	208

*The duration was determined as accurately as possible, but there are doubtless small errors in some of the cases, especially in dating onset of jaundice as noticed by patient or friends.

TABLE III

CLEARING OF JAUNDICE IN CASES OF HEPATITIS IN RELATION TO DURATION OF THE DISEASE

DURATION (WEEKS)	NO. OF CASES BEGINNING TO CLEAR	PERCENTAGE OF WHOLE
5	29	100
4	24	83
3	14	48
2	8	28
1	2	7

From Table II some other points of interest can be deduced. Hepatitis is not particularly a disease of young people as some propose. Table IV shows, for example, that two-thirds of our cases were between 31 and 50 years of age, and there were nearly as many in the sixth and seventh decades as in the first three. The fact that the patient is not young does not therefore justify the surgeon in passing over the possibility of hepatitis.

TABLE IV

AGE DISTRIBUTION OF CASES OF HEPATITIS

DECADE	NO. OF CASES	PERCENTAGE
1-10	1	3.5
11-20	1	3.5
21-30	4	14.0
31-40	10	38.0
41-50	8	28.0
51-60	2	7.0
61-70	3	10.0

Table II shows also that there is no exact relation between the intensity of the jaundice and its persistence. A profound jaundice may resolve quickly; a milder icterus may persist for weeks.

DISCUSSION AND SUMMARY

An inquisition of experienced surgeons revealed the general feeling that exploratory laparotomy should be done in undiagnosed cases of recent intense jaundice after only a brief (one to two weeks) period of observation. The same opinion is expressed in the literature. We have pointed out that such a period is far too short to eliminate most cases of acute hepatitis, a condition in which surgery is not only useless but may be harmful. Actual statistics on the duration from onset of jaundice to beginning of resolution show that a period of observation of at least a month is necessary to rule out hepatitis with any degree of certainty. In contrast to surgeons, internists, perhaps more aware of the occasional case of hepatitis which does not resolve for two or three months, are inclined to wait too long before advising operation.

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PAPILLARY CYSTADENOCARCINOMA OF THE PANCREAS

HARRISON E. KENNARD, M.D., BOSTON, MASS.
(From the Surgical Service of the Massachusetts General Hospital)

A PATIENT suffering from papillary cystadenocarcinoma of the pancreas was seen recently at the Massachusetts General Hospital. Lichtenstein,[28] in 1934, reported a case showing this lesion, and stated that there appeared to be no previous authentic case in the American literature. He reviewed the literature up to 1934. Proved recorded instances of this rare disease are so few that it was considered desirable to report this recent case in detail. A brief review of the literature is given below and is followed by a presentation of the case.

Incidence.—Any sort of a cyst of the pancreas is uncommon, and malignant pancreatic cysts are rare. White[48] found only 3 cases of pancreatic cyst among 6,708 autopsies at Guy's Hospital in London. Young[49] reported in 1937 that there had been only 5 cases of pancreatic cyst recorded at the Massachusetts General Hospital during the previous seventeen years, and that 2 of those 5 had developed malignancy. No further pancreatic cysts have been recorded in that hospital since 1937. Friedenwald and Cullen[10] reported malignancy in 3 out of a series of 7 pancreatic cysts. However, the incidence of malignancy in these two small series must be relatively high, for Mahorner and Mattson[30] state that, among 88 patients with pancreatic cysts treated surgically at the Mayo Clinic, there were only 4 with carcinomatous cysts, or 4.5 per cent. Lazarus[26] mentions a series of 14 pancreatic cysts without a single instance of malignant degeneration.

Cases of malignant or probably malignant pancreatic cysts which have been more or less completely reported in the literature seem to be few enough to present in one small table (Table I). In a textbook of special pathologic anatomy by Kaufman[23] there is mentioned one case of malignant papillary cystadenoma of the pancreas in a 42-year-old woman, but no case history is presented. Several other instances of this disease have been mentioned in the literature, but they were very incompletely reported. Of the 21 cases in Table I in which sex was mentioned, 10 were males and 11 were females. Age varied from 34 to 79 years, with an average of 53 years. McWhorter[32] reported that cysts of the pancreas occur about equally in males and females. Oser[34] in a series of 121 cases of pancreatic cyst found 60 in males and 61 in females, and reported that, statistically, pancreatic cysts occurred in men most commonly in the fourth decade and in women in the third decade. In our series of malignant pancreatic cysts, as would be expected, the age group is slightly older. On the other hand, Leven[27]

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TABLE I

PROBABLE MALIGNANT CYSTS OF THE PANCREAS

CASE	AUTHOR	AGE	SEX	SYMPTOMS	OPERATION	RESULT	PATHOLOGIC REPORT
1	Baehr and Klemperer[3]	50	F	Vomiting and abdominal pains 2 yr.; upper abdominal mass 2 yr.	None	Died 2 yr. 10 mo. after onset of illness	Autopsy showed cystadenoma of body of pancreas with metastases
2	Boston City Hospital (No. 768395)	34	F	Epigastric pain; pain in back; vomiting 4 wk., loss of 20 pounds; jaundiced; urine negative	Exploratory laparotomy; biopsy of liver	Died 12 days postoperatively	Autopsy showed large hard pancreas, 6 cm. cyst in tail; liver metastases "papillary cystadenocarcinoma"
3	Burbank Hospital (Fitchburg, Mass.) (No. 70447)	72	M	Abdominal soreness several months; jaundice 2 mo.	None	Died	Adenocarcinoma head of pancreas; papillary adenocystoma of head of pancreas, size of walnut
4	Fitz[9]	36	M	Pain in lower dorsal and lumbar regions 3 mo., with development of upper abdominal tumor	Excision	Recovery from operation	(?) Malignancy
5	Friedenwald and Cullen[10]	50	F	Abdominal swelling, 3 yr. with occasional attacks of colic, nausea, and vomiting	Drainage	2 yr. postoperatively had developed jaundice, glycosuria, and recurrent mass	None
6	Friedenwald and Cullen[10]	58	F	Recently observed mass in left upper abdomen; weight loss and indigestion; urine, sugar—0	Marsupialized	Mass recurred; wound ulcerated; died 6 yr. postoperatively	Biopsy of wound ulceration showed "adenocarcinoma" just before death

7	Friedenwald and Cullen[10]	56	M	"Indigestion" 15 yr.	Drainage	Marsupialized 5 yr. after first operation and died 6 mo. later	(?) Adenocarcinoma
8	Gallagher[11]	79	M	Loss of weight for 10 mo.; abdominal tumor noticed 1 mo.	Drainage	Died 5 wk. later	Autopsy showed "carcinoma of the pancreas"
9	Hartmann[15] (Fitz[9])	53	F	3 mo. of epigastric pain	Marsupialization	Died 6 wk. later	Autopsy showed cystic epithelioma of pancreas
10	Hopkins[17]	76	M	Jaundice 5 wk.; loss of weight; dragging sensation in region of stomach; glycosuria first noted 3 days before death	None	Died 5 wk. after onset of jaundice	Autopsy showed 7 cm. benign pancreatic cyst with carcinoma in its wall
11	Lichtenstein[28]	44	F	Upper abdominal tumor 6 yr. with ascites	None	Died	Post-mortem examination showed papillary cystadenocarcinoma of pancreas with metastases to peritoneum, omentum, and liver
12	Luecke (Senn[40])	43	F	Abdominal swelling increasing for 6 mo.	Drained 27½ pints of ascitic fluid at laparotomy	Died 3 days postoperatively	Multilocular pancreatic cyst; microscopic: colloid cancer evidently with origin in pancreas and carcinomatosis
13	Mahorner and Mattson[30]				Laparotomy disclosed large cystic tumor with nodules on its surface and in liver; biopsy of liver nodules		Carcinoma

TABLE I—CONT'D

CASE	AUTHOR	AGE	SEX	SYMPTOMS	OPERATION	RESULT	PATHOLOGIC REPORT
14	Mahorner and Mattson[30]				Part of cystic mass 20 by 25 cm. of pancreas was removed	Recovery from operation	Cystadenocarcinoma
15	Mahorner and Mattson[30]				Cystic tumor containing 4 liters of fluid removed from tail of pancreas		Carcinoma of pancreas
16	Mahorner and Mattson[30]				Pancreatic cyst was drained	Died following operation	Autopsy showed carcinoma of pancreas
17	Massachusetts General Hospital (No. 246951)	34	M	Epigastric pain (2 yr.); urine negative	Drainage	Recovery from operation	Cyst wall shows an occasional mitotic figure
18	McWhorter[32] (a) Kahlke	45	F	Pancreatic cyst operated on 13 yr. before; tumor recurred 10 yr. later	Drainage	Died 2 mo. after biopsy	Biopsy of sinus 18 mo. after second operation showed malignant papillary adenoma
19	(b) Phemister	64	M	Pains in abdomen and back 6 mo.; abdominal tumor 3 mo.	2,000 c.c. clear fluid aspirated, mesenteric biopsy	Died 3 mo. postoperatively	Adenocarcinoma
20	(c) Graham	68	M	Progressive jaundice, fullness in epigastrium; weight loss 2½ mo.	Drainage of small cyst; hard mass in head of pancreas	Died day of operation	

21	(d) David	45	M	Rapidly growing tumor filling abdomen; weight loss	Aspiration 4,000 c.c. bloody fluid; abdomen closed without drainage	Died few days postoperatively	Autopsy showed "degenerating cystic tumor"; microscopic: "degenerated tissue"
22	Mixter	40	F	Painless swelling of abdomen 3 to 4 yr.; urine, sugar, "green without sediment"	Total excision	Doing well 10 mo. postoperatively	Papillary cystadenocarcinoma of pancreas
23	Prosorowsky[36]	78	M	No pancreatic symptoms	First stage suprapubic prostatectomy	Died postoperatively	Post-mortem examination showed pancreatic tumor containing a few small cysts and one nodule of malignant degeneration
24	Speese[42]	49	F	Cyst of pancreas operated on 10 yr. before (partial excision and marsupialization); urine, no sugar	Marsupialization, followed 7 yr. later by excision of tumor of abdominal wall	Well 7 yr., then developed malignant cystic adenoma which was excised	"Proliferating cystadenoma of the pancreas" (second operation)
25	Young[49]	34	F	Painless abdominal swelling 4 yr.; weight loss several months	Partial excision; marsupialization	Died 7 yr. later of malignancy; proved by biopsy of sinus tract before death	Multilocular cystadenoma at operation

collected 566 cases of pancreatic carcinoma and found that males were twice as frequently affected as females. Pancreatic cysts are usually a disease of middle life. Among 112 cases of Müller,[33] 70 were between 20 and 50 years of age. Hulke[20] reported a case in a 47-year-old woman in whom an abdominal tumor had been noticed since girlhood (about forty years).

Etiology.—It seems to be agreed generally that pancreatic cysts are usually the result of some sort of obstruction to the normal secretion of the pancreatic juice in the organ. Wangensteen[45] states that the most frequent antecedent of a large serous cyst of the pancreas appears to be a prior attack of pancreatic necrosis. It is easy to suppose that, following pancreatitis, fibrous contraction exerts pressure on the pancreatic ducts sufficient to cause obstruction. Retention cysts are probably due to this. However, cystadenomas may be due to accumulation of fluid in cavities that are formed by spontaneous proliferation of the epithelial elements of the gland. Priesel[35] believes that, if there is proliferation of the cylindrical epithelium of a pancreatic duct, it may go on to form a cystadenoma or even an adenocarcinoma without infiltrating growth. He states that most authors believe that cystadenomas of the pancreas are due to aberrant pieces of pancreatic tissue which have become isolated.

Ballin and Saltzstein[4] cite one case of a nonmalignant pancreatic cyst which developed two months after cholecystectomy, and could find no record of any other similar case. This must be very rare. However, Judd[21] found gall bladder disease associated with cysts of the pancreas in 17 of his series of 41 cases. Horrocks[18] reported an autopsy on a case of benign pancreatic cyst associated with glycosuria and gallstones. The cyst contained about two pints of fluid, and a stone the size of a pigeon's egg was found loosely impacted in the common bile duct. Archibald and Kaufman[2] state that the pancreatic adenocystomas are true tumors, like the corresponding tumors of the ovary, and that they arise from the parenchymal cells by proliferation. They are, therefore, glandular structures lined with cuboidal epithelium.

Lichtenstein,[28] in his excellent detailed account of a case of papillary cystadenocarcinoma of the pancreas, stated that one is justified in assuming that in his patient the lesion started as a benign cystadenoma. This patient was free of any local or constitutional sign of cancer for at least five years in the presence of an upper abdominal tumor. Histologic examination of this tumor demonstrated that some of the cyst wall still showed the structure of a benign multilocular cystadenoma. Oser[34] believed that in the formation of cysts of the pancreas the closure of the pancreatic duct may cause stagnation and accumulation of the pathologic products, but can never be the sole cause of retention of the pancreatic juice in an otherwise normal gland. Hopkins[17] cites a case of pancreatic cyst which at autopsy showed what was considered to be either a carcinoma developing in the wall of a benign pancreatic

cyst or a cyst due to compression of the ducts by a malignant growth. Maes[29] reported the removal of a cyst of the pancreas in which the pathologic report was cystadenoma, the chief histology being characteristic of a benign new growth, although occasional areas were observed in which an infiltration tendency was apparent.

In the ovary, papillary cystadenocarcinoma resulting from malignant proliferation of the epithelium lining a benign cyst occurs not infrequently. In the pancreas this seems to occur only rarely.

Pathology.—There are many different classifications of pancreatic cyst in the literature. Boyd,[5] in his textbook of pathology seems to have the simplest classification. He divides cysts of the pancreas into retention cysts, congenital cysts, cystadenomas, and pseudocysts. Pseudocysts are the common variety, but they are not true cysts of the pancreas and have no epithelial lining. They are usually situated in the lesser peritoneal cavity in front of the pancreas. This cyst is preceded by some injury to the pancreas, either trauma or hemorrhagic pancreatitis. As a result of upper abdominal injury, pancreatic secretions escape into the lesser peritoneal sac and, as the foramen of Winslow becomes sealed, a cyst develops. Stevenson[43] reported a typical case of this in a farmer whose upper abdomen was trampled on by a horse. Cushing[8] described another case following a blow on the abdomen. According to Boyd,[5] cystadenomas of the pancreas are rare tumors which may be benign or malignant. They are usually benign. McKechnie[31] believes that multilocular cysts are likely to be malignant.

Lichtenstein[28] subdivides the malignant pancreatic cysts into three classes: Essentially solid adenocarcinomas with epithelial-lined cysts; large epithelial cysts with carcinoma in the pancreas outside the cyst wall; and papillary cystadenocarcinomas.

Pancreatic cysts may originate from any part of the pancreas and may present above or below the stomach, and even below the transverse colon. Heiberg[15] believes that the favorite site for cystadenoma is the tail of the pancreas. Lazarus[26] states that the rarest position for a pancreatic cyst is in the head of the pancreas. The most common position into which the cyst grows is between the stomach and the transverse colon.

The cyst fluid may be clear, cloudy, straw-colored, greenish, brown, or bloody. Tilger[44] found that among 18 cases of pancreatic cysts there were 4 which showed no evidence of any pancreatic ferments present in the cyst contents. According to Judd,[21] one or more pancreatic enzymes are usually present in pancreatic cysts. This may be used as a distinguishing feature because, if the fluid will coagulate egg albumen or split starch, it is probably pancreatic in origin. Speese[42] reported a benign cyst, the contents of which showed pancreatic ferments. Seven years later (Table I), the case developed a malignant cystic adenoma in the abdominal wall, the origin of which may well

have been in the remains of the pancreatic cyst. Lichtenstein[28] reported the autopsy of a patient dead of papillary cystadenocarcinoma of the pancreas and found diastase but not trypsin in the cyst contents. According to Friedenwald and Cullen,[10] the contents of pancreatic cysts are ordinarily alkaline, with a specific gravity of 1,010 to 1,020, and it frequently contains one or more of the pancreatic ferments.

The blood supply of pancreatic cysts is usually very generous. It is reported by Robson and Moynihan[38] that the splenic artery and vein may be found running either in front of or behind the tumor. The superior mesenteric vessels may cross the anterior aspect of the cyst.

Symptoms.—The patient may have no symptoms except for a painless swelling of the abdomen, as in the case reported below. The metabolic and digestive functions of the pancreas are usually insufficiently disturbed to attract much attention. However, ordinarily there is a long history of abdominal discomfort, sometimes resembling that of a mild cholecystitis. There may be flatulence and anorexia, and sometimes jaundice. If interstitial pancreatitis accompanies the cyst formation, there may be emaciation; large, fatty stools; muscle fibers in the stools; and sugar in the urine. This usually is not the case. Pain is due to pressure on adjoining organs. Pressure on the stomach may cause nausea and vomiting. The two cases of malignant cyst in Judd's[21] series suffered from loss of weight; one lost ten pounds in three months, and the other seventeen pounds in a year.

The most important symptom is a large, slowly growing, nontender, upper abdominal tumor mass. According to Oser,[34] in most cases one to three years elapse between the first symptoms of the disease and the time when the cyst is first observed.

Diagnosis.—The diagnosis of a cyst of the pancreas is not always easy, and whether or not it has undergone malignant degeneration is usually impossible to determine without biopsy. Carter and Slattery[7] remark that in cases of cystadenoma of the pancreas there are no diagnostic physical signs and no diagnostic laboratory procedures, the diagnosis, if made, being by the process of exclusion of other possibilities. This seems to be true for all pancreatic cysts.

Differential diagnosis of a pancreatic cyst includes ovarian cyst; pedunculated fibroid; pregnancy; hydronephrosis; mesenteric, splenic, and omental cysts; echinococcus cyst of the liver; hydrops of the gall bladder; retroperitoneal tumor; and aortic aneurysm. Ovarian cyst, pedunculated fibroid, and pregnancy can usually be ruled out by pelvic examination. Ovarian cysts are characteristically more mobile than pancreatic cysts. In ovarian cysts the hollow viscera tend to be pushed backward, and in pancreatic cysts forward. Hydronephrosis can be ruled out by pyelogram. Hueper,[19] however, cited a case of cystadenoma of the pancreas in which the tumor had caused a hydronephrosis, evidently by pressure on the left ureter. Mesenteric and omental cysts are usually mobile. Splenic cysts arise from the left side. Echinococcus

cysts of the liver and large hydrops of the gall bladder arise from the right upper quadrant, and on percussion usually can be shown to be part of the liver or continuous with it. Retroperitoneal tumor other than pancreatic cyst usually feels solid rather than fluid. Aortic aneurysm shows marked pulsation.

Diabetes mellitus was present in 3 out of 47 cases in Judd, Mattson, and Mahorner's[22] series of pancreatic cysts. As shown in Table I, the present case and one other are the only malignant pancreatic cysts with a definite glycosuria, although the urine was reported in only 6 of the 25 cases. Leven[27] states that in his series of 566 cases of pancreatic carcinoma glycosuria was an infrequent finding. Diabetes occurred in only 9 out of 134 cases of pancreatic cyst reviewed by Oser.[34] A case of benign pancreatic cyst which was marsupialized four years after the patient had developed diabetes and one year after the cyst was first noticed was described by Hoon.[16] Sodeman[41] reported 1 case of cystic disease of the pancreas with apparent disappearance of diabetes following operation.

Whipple[47] suggests giving barium simultaneously by mouth and by rectum as a diagnostic procedure. In many cases pancreatic cysts will push the stomach upward and to the right and will also push the transverse colon downward. After giving barium from above and below, x-ray will show the pancreatic cyst bulging between the stomach and the transverse colon. Fluctuation of the cyst mass sometimes can be observed on palpation. In 1903, Oser[34] suggested outlining the stomach in relation to a pancreatic cyst by means of the administration by mouth of tartaric acid and sodium bicarbonate, thus distending the stomach with gas. According to Wangensteen,[46] pancreatic cysts occasionally transmit pulsations from the abdominal aorta which lies beneath.

Typically, a diagnosis of pancreatic cyst should be considered in any middle-aged or elderly patient with a slowly enlarging, painless, cystic retroperitoneal tumor in the upper abdomen. In only 7 out of 460 cases in Müller's[33] series was the cyst said to be freely movable. The mass felt in cases of pancreatic cyst is dull to percussion. It may become so large that its center will slip down below the umbilicus, and thus may seem to arise from the pelvis, as in the case reported here.

Complications.—The complications of pancreatic cysts are hemorrhage into the cyst, perforation into the peritoneal cavity or gastrointestinal tract, and malignant degeneration. There may be jaundice from pressure on the common bile duct. Malignant cysts usually cause a slow death of the patient by extension and metastases.

Treatment.—If the patient will stand surgery, operation is always indicated. In the case of a benign cystadenoma many have been cured by marsupialization of the cyst. This procedure is, of course, futile in a malignant cyst, which should always be excised completely if possible. Excision may be difficult and dangerous, since the cyst often is very adherent to surrounding tissues, and also because part of the pancreas

itself may have to be removed. In Judd's[21] series of 41 cases of pancreatic cyst, the entire cyst was removed in only 5 cases. He believed that, if too much of the pancreas was removed, diabetes might ensue.

Bozeman[6] is usually considered the first surgeon to have successfully removed a pancreatic cyst. In 1882 he published an account of removing a cyst of the pancreas weighing 20½ pounds. This operation was performed "under Listerism." The cyst was reported to have had a pedicle only three-quarters inch in diameter.

When complete extirpation is impossible, marsupialization, first advocated by Gussenbauer[14] in 1883, has become the accepted form of treatment of benign pancreatic cysts. This treatment, of course, functions best with unilocular cysts. Richardson,[37] in 1895, marsupialized a benign pancreatic cyst successfully. Marsupialization is done best by suturing the wall of the cyst to the parietal peritoneum. This produces a fistula, which may drain for months or even years. A case which was still draining from the fistula after fourteen years was observed by Kerr.[24] Wangensteen[45] feels that cystadenomas of the pancreas should always be excised if possible, for he believes that marsupialization fails to cure them and that they may be the progenitors of carcinoma.

Gordin[13] reported a benign pancreatic cyst which he was unable to remove, but which he packed with gauze saturated with sodium morrhuate. He felt that the sclerosing action of the drug was helpful in producing a successful result. Half-strength tincture of iodine and also 25 per cent glucose were used for the same purpose by Angel.[1]

According to Lahey and MacKinnon,[25] postoperative x-ray therapy is distinctly worthwhile in cases of carcinoma of the pancreas. Nothing was found in the literature concerning x-ray therapy of papillary cystadenocarcinoma of the pancreas.

Mortality.—In Judd's[21] series of 41 cases there were no immediate deaths from operation. The treatment was as follows: Drainage of the cyst cavity alone in 31 cases; enucleation of the lining membrane in 3 cases; removal of the entire cyst in 5 cases; and no operation on the cyst in 2 cases. However, in this same series one patient died a little over a month after operation and necropsy showed carcinoma of the liver and pancreas. In one other case "carcinoma was found at the time of operation," and the patient survived several months. Two other patients died within two months of operation, one of acute nephritis, and another of acute hemorrhages, pancreatitis, and acute yellow atrophy of the liver. Schmieden and Sebening[39] collected 128 cases of pancreatic cyst which had been operated upon and found a mortality of 15 patients. Lazarus[26] states that of 131 cases marsupialized by Gussenbauer's technique only 7 cases died, and of 24 cases of extirpation 6 died.

Godel[12] in 227 collected cases of pancreatic cyst found a mortality of only 3 per cent in 190 cases marsupialized, as against a 10 per cent

mortality in 28 cases totally extirpated and 55 per cent in 9 cases partially extirpated.

In Table I, 23 of the 25 cases of probable malignant pancreatic cyst were reported as to end result. The known mortality within seven years of operation was 57 per cent. Nine of the cases died within two months of the operation, and 4 more died within seven years. Four cases died unoperated upon. One case showed recurrence two years after operation. Five recovered from one or more operations and their future courses were not reported.

CASE REPORT

M. W., a white, single, 40-year-old housekeeper, was first seen on Jan. 23, 1939. Her chief complaint was a swelling of the lower abdomen, which had gradually increased in size over the past three or four years. Her appetite had been good. There was no history of abdominal pain. Her bowel movements had been regular without laxative. No abnormal stools had been noted. She had never been jaundiced. There had been no increased urinary frequency. Her weight had remained the same for several years. During the past six months her catamenia had been somewhat irregular and scant.

Two months previously she had had an iridectomy performed on the right eye for acute glaucoma. There had been an excellent convalescence from this operation. Two urinalyses done at that time had been reported negative. The ophthalmologist had noted that her abdomen contained a mass the size of a seven-month pregnancy and had advised her to consult an abdominal surgeon. She had had no previous operations; no history of abdominal injury could be obtained.

Physical examination showed a thin, somewhat pale 40-year-old woman in no immediate distress. The lower abdomen contained a nontender protuberant mass the size of a cantaloupe melon, extending from the pubic symphysis to about 3½ inches below the costal margins. The mass was firm and resistant. No fluctuation could be elicited. It was slightly movable laterally and on deep inspiration moved slightly up and down. Rectal examination showed that the abdominal mass was apparently unconnected with the cervix. The cervix seemed normal in size and position. The mass was then thought to be either an ovarian cyst or a pedunculated fibroid. Urinalysis was again negative, and she was admitted to the Baker Memorial Hospital. The urine specimen taken immediately before operation showed, for the first time, a "green without sediment" test for sugar, using Benedict's solution.

The operation was performed by Dr. Charles G. Mixter. Under ether anesthesia the abdomen was opened through a seven-inch left paramedian incision extending from the pubic symphysis to a point about one and one-half inches above the umbilicus. This made possible the palpation of a large cystic mass which arose from the region of the pancreas. The transverse colon lay flattened over the inferoanterior aspect of this mass, and the transverse mesocolon was pushed down by the inferoposterior aspect of the mass. The gastrocolic omentum lay over the anterior aspect of the tumor with the stomach lying above it. The duodenum lay to the right of the base of the tumor. The tumor itself (Fig. 1) was the size of a large cantaloupe with cystic nodulations and very large veins lying on its surface. An opening was made through the arcade of the transverse mesocolon, carried down to the wall of the tumor, and, although the tumor was adherent to surrounding structures, a fairly good line of cleavage was obtained. Another incision was made through the gastrocolic omentum and a similar line of cleavage was developed. Considerable bleeding was encountered from the unavoidable tearing of small blood vessels, but the entire

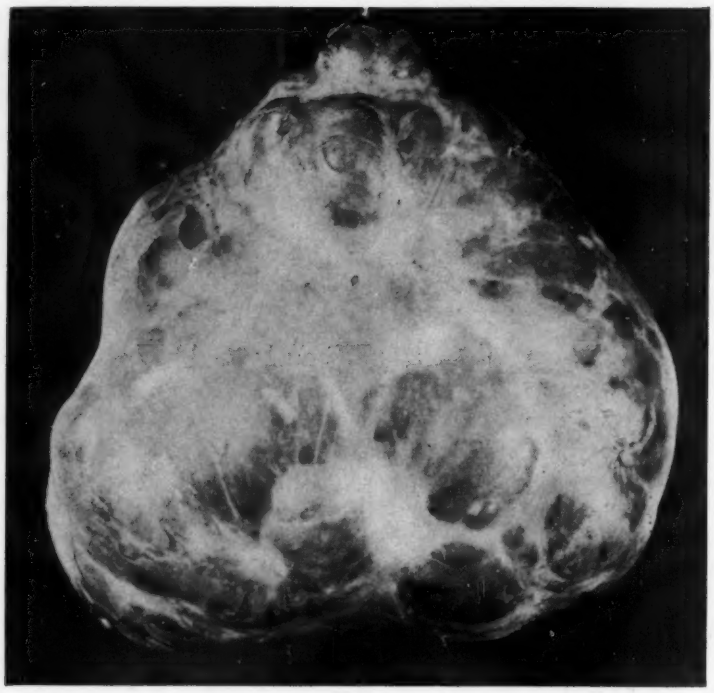

Fig. 1.—Papillary cystadenocarcinoma of the pancreas weighing 2,050 Gm. Note absence of papillary processes on the surface.

Fig. 2.—Photomicrograph showing well-differentiated adenocarcinoma.

mass was enucleated and was found to arise from the body of the pancreas in about the midline, approximately one and one-half inches from the head. The tumor was sessile and had not even a short pedicle. Enucleation of the cyst left a defect about the size of a 50-cent piece involving the midportion and inferior margin of the pancreas, but leaving its superior margin intact. The defect was sutured together with interrupted plain catgut. The rents in the gastrocolic omentum and the transverse mesocolon were then closed with continuous chromic catgut. The circulation of the transverse colon was not impaired. The appendix was then removed and the wound closed in layers, without drainage. A transfusion of 500 c.c. of citrated blood was given following the operation.

Convalescence was excellent. Her temperature never rose over 100° F., and she was allowed up in a chair on the fourteenth day after operation. Postoperative urinalyses and blood sugars showed a mild diabetes, not sufficiently severe to require insulin.

The pathologic report was "papillary cystadenocarcinoma of the pancreas." The tumor (Fig. 1) was described as "a tense, fluctuant, thin-walled, smooth surfaced, purple-red and gray, slightly lobulated cyst measuring roughly 15 cm. in diameter, and weighing 2,050 Gm. On section, dirty brown, thick fluid containing fat droplets is extruded. The cyst wall is lined with a number of nodular green-brown soft masses which project from the surrounding pink wall into the cavity of the cyst. The largest cavity measures 12 cm. in diameter and there are four or five other cavities smaller but similar to the one described. Microscopic examination of the solid masses (Fig. 2) showed a well-differentiated adenocarcinoma."

X-rays of chest, spine, and pelvis showed no evidence of metastatic malignancy. A postoperative gastrointestinal series showed no evidence of obstruction or extrinsic masses.

The patient was discharged home on the seventeenth postoperative day with instructions as to a moderate diabetic diet. She was seen again five weeks after operation and was gaining strength and weight very well. The wound was solidly healed. At last visit, ten months following operation, she had gained eight pounds and showed no evidence of recurrent malignant disease. She was still dieting without insulin for a mild diabetes.

SUMMARY

1. Papillary cystadenocarcinoma of the pancreas is a rare disease of which very few cases have been reported in detail in the literature.

2. The relative incidence of malignant to benign pancreatic cysts varies in different reports, but it is probably about 9 per cent.

3. In its early stages the symptoms of a malignant pancreatic cyst are the same as those of a benign one.

4. The chief early symptom of a benign or malignant pancreatic cyst is a slowly growing upper abdominal tumor, with or without digestive disturbances.

5. The only adequate treatment of a malignant pancreatic cyst is complete excision.

6. A detailed case report is presented of the successful complete extirpation of a papillary cystadenocarcinoma of the pancreas.

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THE SURGICAL ASPECTS OF LIGHTNING STROKE

With a Case Report

A. S. Crawford, M.D., and B. F. Hoopes, M.D., Detroit, Mich.

(From the Department of Surgery, the Henry Ford Hospital)

PEOPLE struck by lightning have presented many unique pathologic changes. Burns, fractures, lacerations, cataracts, and lesions of the nervous system have all been reported. If a person survives the initial shock, the prognosis, as far as life is concerned, is good. However, many cases have been reported where serious sequelae followed apparent recoveries from the initial injuries.

During the years 1924 to 1933 there were 3,849 deaths due to lightning reported within the Death Registration Area of the United States.[32] The mountain and southern states had the highest death rates, over 8 per one million deaths. The northeast and middle Atlantic states had the lowest rate, with 1.3 per one million deaths. Since 1934 there has been a relative increase over the average of 385 for the previous ten years, as follows: 1934, 442 deaths; 1935, 362 deaths; 1936, 409 deaths; 1937, 460 deaths.

Burns are the most common lesions due to lightning stroke and may be of any degree of severity. Reports of bizarre patterns have been recorded, such as arborescent markings, long narrow lines, localized surface burns, and burns made in shapes determined by metal objects in the clothing or pockets.[5, 11, 30] Associated with the burns, large lacerations may be caused by the explosive force of the lightning stroke. Wehe[33] reported a case in which the soft tissues were torn from the right shoulder area, thereby exposing the upper end of the humerus, the clavicle, and the muscles of that area. Hegner[15] reported compound fractures of the bones of the foot associated with considerable destruction of the soft parts. Perhaps the most common burn is the linear type, which marks the path of the electricity between two points on the body's surface. That part of the body which is in contact with a metal object at the time of injury usually suffers the greatest degree of trauma. In Benjamin's[3] case the patient was driving a truck and a large burn on his thigh was apparently the point of contact with the car. Elwell[12] reported the case of a boy who received a large burn and laceration of the arm in which he was carrying a metal bucket. Dunscombe-Haniball[9] reported a patient who received a large burn over the right side of the body and right shoulder where he was carrying a pitchfork.

Frequently the hair of the head or eyebrows is singed without associated deep burns of the skin. The most unusual report is that of

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Ashby[1] in which three children developed a left-sided alopecia two weeks after they were struck by lightning. They had a return of their hair in approximately six months.

Among the organs of special sense that have been affected by lightning stroke are the ears and eyes. Silverman[29] reported a case of unilateral deafness. The ear bled for three days after the accident, but the author did not state whether or not spinal fluid also came from the ear. Examination of the ear, when the bleeding had stopped, showed reddening of the tympanic membrane but no lacerations of the drum or canal. Slingerland[30] reported a case of conjunctivitis and internal strabismus which recovered without sequelae. Lea's[23] case of conjunctivitis and paresis of the ciliary muscles improved somewhat, but the eyes had remained weak and irritable up to the time the case was reported. Cataracts have been noted with some degree of frequency following lightning stroke.[4, 10, 17, 24, 27, 32] Several authors have reported good results following operation for this type of traumatic cataract.

Lesions of the nervous system following lightning stroke have been very bizarre and varied.[5, 8, 25, 26] Muscular weakness and paresthesias have been the most common findings. Complete paralysis, either permanent or temporary, has been recorded and in each case the question of hysteria has arisen. The return of function has been so rapid in some cases that the exact location and type of the pathologic lesion may be under dispute. Critchley[6] described seven pathologic findings in people injured by lightning or electricity: (1) local petechial hemorrhages throughout the brain; (2) softening and edema of the brain; (3) ballooning of the myelin sheaths of the peripheral nerves and changes in the nerve fibers themselves; (4) fragmentation and tortuosity of the axones, breaking down of the sheaths of Schwann and fusion of their nuclei; (5) a change to a spiral-like appearance of the muscles; (6) dilation of the perivascular spaces in the brain stem and cord, probably due to the electrolysis; and (7) chromatolysis of the nerve cells of the cord and brain. These varied pathologic processes explain many of the unusual clinical pictures found in the literature. In some cases, however, it is difficult to correlate the localized areas apparently involved and the reported signs and symptoms.

The authors have been able to find reports in the literature of five skull fractures caused by lightning stroke and one case in which a sequestrum was spontaneously extruded three months after the injury. Death had occurred practically instantaneously in all cases, except the one with the sequestrum, and in several there were large burns or lacerations associated with the cerebral injury. Schottin[28] described the first case in 1831. This patient was in profound shock when first seen and he died soon after this. There was present a large stellate fracture of the right parietal bone immediately underlying a laceration of the scalp.

Post-mortem examination of the brain did not reveal any gross pathologic changes. Heffernan[14] reported a second case of skull fracture in 1877. Post-mortem examination revealed a diamond-shaped fracture of the right orbital plate and a layer of semifluid blood overlying the right hemisphere of the brain. No pathologic change was noted in the brain substance. Knaggs[21, 22] described a bilateral vault fracture which extended into the base. . The cerebrospinal fluid was under increased pressure at the time of the post-mortem examination. The brain surface was injected and the vessels of the meninges were engorged with fluid blood. This was most marked in the arachnoid near the fracture. The brain substance was abnormally soft but not lacerated or necrotic.

Dunscombe-Haniball[9] reported two fatal cases of skull fractures caused by lightning. Post-mortem examination in one showed a compound depressed fracture of the skull with a normal-appearing brain. In the other there were multiple simple fractures with some softening of the brain. Herrman[16] reported a case in which a sequestrum of the skull, 3 cm. in diameter, was spontaneously extruded three months after an injury by lightning. A large ulcer of the scalp had been present over the sequestrum and there had been accompanying signs of cerebral injury on that side.

We are reporting this case because of the somewhat unusual type of trauma and because of the recovery from lesions which formerly had resulted in death.

CASE REPORT

History of the Accident.—Inasmuch as the patient still has a complete amnesia for the details of the accident, we must depend upon circumstantial evidence and the history obtained from her husband. It is known that the patient was standing against the metal sink in her kitchen, washing the lower plate of her false teeth, when the house was struck by a large bolt of lightning. This had apparently come in along the electric light wires and grounded through the sink. The patient was found by her husband a few minutes after the accident lying upon the floor unconscious. A large piece of plaster, 2 by 2 feet in size, had been knocked out of the wall and the metal medicine cabinet which had been on the wall above the sink was found lying on the floor. The electric light meter which had been on an inside wall was found torn from its fastenings and one connecting wall plug was likewise damaged. The patient arrived at the Henry Ford Hospital at 3:40 P.M. Sept. 9, 1939, approximately one and one-half hours after the accident. She was still unconscious and could not be aroused.

Examination.—The most striking thing, when the patient was first observed, was her general appearance. She appeared to be in deep shock, and still her blood pressure was 120/80 and her pulse 72. She had no respiratory embarrassment and the rate was 20 per minute. Her clothes were torn and burned, especially in the front and on the right side, as shown in Fig. 1. She had a number of leather-covered metal hair curlers scattered throughout her hair and no burns were present under these. The hair over the right parietal and mastoid areas was singed, as were the eyebrows and eyelashes. The right ear was almost completely torn off and the upper one-third missing. There was a large irregularly charred and macerated laceration of the skin in the right mastoid region which measured 4 by 2 cm. The mastoid bone also appeared to have blown open, its edges being jagged and charred. Sanguineous spinal fluid dripped briskly from the canal of the right ear.

Fig. 1.—Photograph of dress which the patient was wearing at the time of the accident. Her corset and underclothes were also torn and burned.

Fig. 2.—Photograph of right side of face, showing laceration and injured ear, one week after the accident.

The pupils were equal and regular, but the right eye deviated outward and upward. The entire right side of her face and neck was covered by a first degree burn, and there was a second degree burn over most of the anterior chest wall. Both wrists had small second degree burns and were lacerated. The skin over the pubis had several small lacerations and a second degree burn was present. The pubic hair was singed. (Figs. 2, 3, and 4.) Examination of the chest and abdomen was negative

Fig. 3.—Photograph of chest and wrists, showing burns one week after accident.

Fig. 4.—Photograph of pubis, showing burn and loss of hair, one week after accident.

except for the above-mentioned burns and lacerations. The deep tendon reflexes were all present and equal on the two sides but somewhat diminished. No pathologic toe signs or clonus were present.

Course in the Hospital.—The evidence of shock promptly disappeared. Approximately one and one-half hours after the accident she began to move her extremities voluntarily, although she did not respond to commands. She vomited on one occa-

sion while the laceration of the right mastoid area was being débrided and sutured. Very gradually she regained consciousness and about six hours after the accident she could answer very simple questions, but she remained stuporous and quiet. The burns were tanned by the usual method with resorcitannol jelly and healed rapidly. Sulfanilamide was started on the day after admission as a prophylactic measure against meningitis, which we felt would be a fatal complication. In the first twenty-four hours she developed edema of the right eyelid which slowly disappeared during the succeeding three days. The external strabismus disappeared by the second day. The patient's temperature remained around 100° F. by rectum for four days and suddenly rose to 104° F. At that time she became more stuporous and had questionable neck rigidity. Lumbar punctures were done daily for six days. Cultures of the spinal fluid were negative. The cell count was 2,600 W.B.C. with 29 per cent polymorphonuclear cells and 71 per cent lymphocytes in the first specimen of spinal fluid. Chemical analysis of the spinal fluid showed the protein to be 260 mg. per cent and the sugar to be 122 mg. per cent. Sulfanilamide therapy was continued and hypertonic glucose was given intravenously periodically. She was placed in an oxygen tent and five small transfusions were given over a period of eleven days. After spinal drainage was started, she gradually improved. Lumbar punctures were done for six days. Fortunately there was no involvement of the heart or lungs. Early in her recovery she spoke with a high-pitched monotone and cerebration was very slow. As she improved and her temperature became normal she gradually regained her normal voice and intelligence. When she first was allowed out of bed and began to sit up in her room, she had an unexplained temperature of 102.8°, but it subsequently went to normal and remained so.

The burns healed as rapidly as those of a similar size and degree that are acquired in other ways. The laceration behind the right ear, which had been carefully débrided upon admission, healed without infection and the remaining portion of the ear attached itself in spite of the meager blood supply. Spinal fluid stopped draining from the ear on the seventh day after the accident.

At the time of discharge, thirty-four days after the injury, she was able to be up and about her room. Her vision was good and her husband noted no changes in her personality which could be attributed to the accident. Hearing in her left ear was fair, but poor in the right with almost complete nerve deafness. The right eardrum appeared markedly scarred in the posterior quadrant.

Discussion.—Although, at the time of débridement, it had not been possible to approximate the skin edges of the mastoid wound, it did heal normally. This experience substantiates that of Gem[13] and Slingerland,[30] who reported normal healing of wounds. Hegner,[15] Elwell,[12] and Dunscombe-Haniball[9] stated that burns due to lightning heal slowly and Critchley[7] warned against hemorrhage and necrosis. The skull fracture, although not verified by x-rays, was proved clinically by the cerebrospinal otorrhea which lasted a week.

As stated above, we cannot be certain how much trauma resulted from the lightning and how much might have resulted from the fall to the floor. Because of the charred blown-open appearance of the mastoid wound and the blown-off appearance of the ear, it seemed that this part of her body had definitely been the contact point for either the entrance or exit of the lightning.

SUMMARY

We have described what seems to be the first case which recovered from a skull fracture with brain injury resulting from a lightning stroke. A prolonged cerebrospinal otorrhea ceased spontaneously, uncomplicated by meningitis, possibly due to the prophylactic use of sulfanilamide.

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PLEURAL EFFUSION ASSOCIATED WITH OVARIAN FIBROMA (MEIGS' SYNDROME)

FRANKLIN I. HARRIS, M.D., AND MORTON A. MEYER, M.D.,
SAN FRANCISCO, CALIF.
(From the Mount Zion Hospital)

THE more common causes of massive pleural effusion are well known and easily diagnosed. Tuberculosis, pneumonia, cardiac failure, malignancy of the lung, and metastatic malignancy explain the great majority of cases of hydrothorax. That fluid in the chest may occasionally be due to a benign pelvic tumor until recently has remained unrecognized. In 1937 Meigs and Cass[1] reported seven cases of pleural effusion and ascites associated with a benign ovarian tumor (fibroma), in which the pleural effusion was cured by the operative removal of the ovarian fibroma. Rhoads and Terrell[2] also reported a similar case, and in a later report by Meigs[3] in 1939 he had collected fifteen cases, all showing similar characteristics of pleural effusion and ascites apparently due to a benign ovarian tumor. Although no satisfactory explanation of why pleural effusion should occur in a patient with a benign ovarian fibroma has been offered, it, nevertheless, is now well established that it can and does occur. It is of the utmost importance that internists and surgeons alike be made cognizant of these facts; for otherwise the occasional patient exhibiting this syndrome may be doomed as hopeless and inoperable.

The following case report, which will represent the sixteenth reported case in the literature, illustrates the importance of knowledge of this syndrome.

CASE REPORT

Mrs. S. S., aged 67 years, white, American, and a widow, was admitted to the Mount Zion Hospital on July 27, 1939, complaining of: (1) shortness of breath, (2) fatigue, (3) pain in the right chest, and (4) difficulty in lying on the right side.

The family history was negative for tuberculosis and malignancy. The patient has two children living and well, aged 39 and 42 years.

Past History.—During the past thirty years, she had enjoyed unusually good health and had been attended for various minor ailments at intervals by her physician who had kept an accurate medical record on this patient during this period of years. Of interest in relation to her present condition are his notes showing that the patient had had an uneventful menopause in 1926. In 1933 she had a vaginal plastic operation for repair of a cystocele, and the surgeon's pelvic examination at that time showed no evidence of a tumor in the pelvis.

In April, 1935, during routine general physical examination, her physician noted a small mass in the left fornix, apparently attached to an atrophic uterus. By August, 1935, this mass had increased in size, and felt like a growing uterine fibroid. X-ray treatments were given at that time to this tumor, although no symptoms

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were being produced by it. Re-examination of the pelvis in July, 1937, still showed the presence of a small tumor in the left fornix, but as the patient was in good health no further treatment was suggested.

In March, 1938, vaginal examination showed the tumor to have increased considerably in size. It was firm and occupied almost the entire pelvis. The tumor was freely movable and strongly suggested a growing, pedunculated uterine fibroid. The patient was in excellent health. There had been no vaginal bleeding and no other symptoms referable to the tumor so no treatment was advised, and the patient was not seen again by her physician until September, 1938. At this time she complained of pains across the shoulder and some slight dyspnea on exertion, which was attributed to a beginning failure of her myocardium.

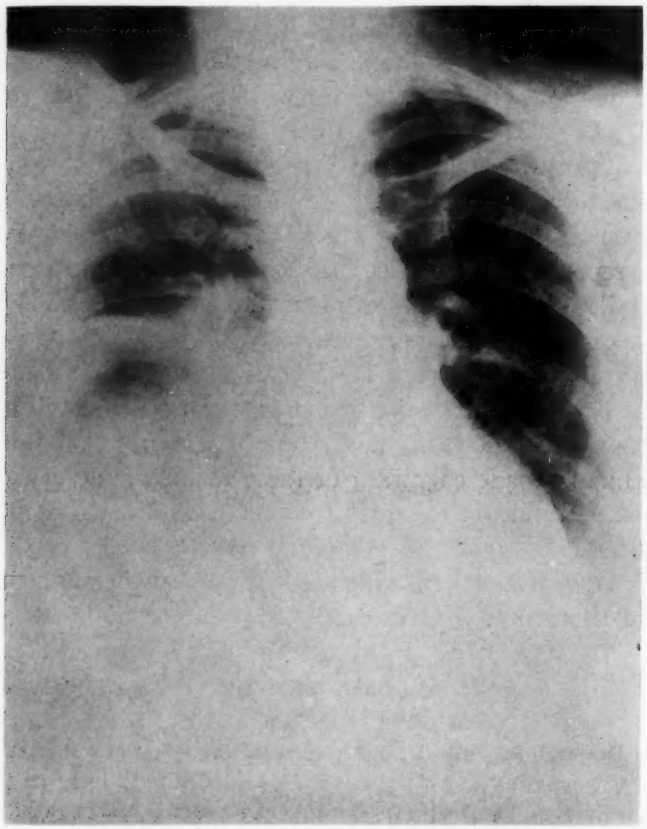

Fig. 1.—Massive pleural effusion in right side of chest.

During the next few months, she began to show evidence of increasing weakness, easy fatigue, dyspnea, and loss of weight. She visited her daughter in Los Angeles, who referred her to an excellent internist of that city for a complete check-up examination. Gastrointestinal x-rays, chest films, and electrocardiograms, as well as other studies, were made at this time. The presence of a small amount of fluid in the right chest was noted. This fluid was aspirated and studies, including guinea pig inoculation, were reported as essentially negative. The examining physician concluded that the fluid in the chest, inasmuch as it was unilateral and no other signs of congestive heart failure were present, did not represent a failing myocardium, but most probably represented a pleural effusion as the result of a malignancy of the lung.

The patient returned to San Francisco in March, 1939, under the care of her own physician, who reviewed the findings of the Los Angeles internist, and further noted that the pelvic tumor had increased considerably in size and that there was present a small amount of fluid in the abdomen. At this time, there was noted a marked increase in the amount of the pleural effusion, as demonstrated by a chest film (Fig. 1). The patient was now practically bedridden because of her dyspnea and increasing weakness, but it was thought advisable to give her an intensive course of deep x-ray therapy to the pelvic tumor. This was done during the early part of July, 1939, with no improvement in the patient's condition, although it was thought that the pelvic tumor had decreased slightly in size.

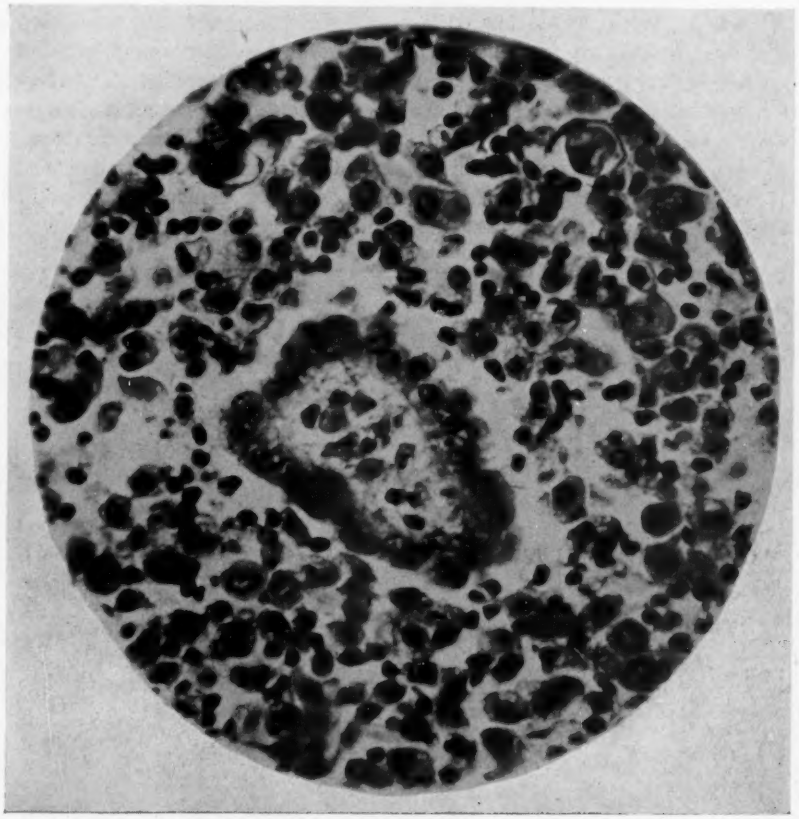

Fig. 2.—Photomicrograph of centrifuged pleural fluid. Cellular sediment is composed of mononuclear mesothelial cells, lymphocytes, and polymorphonuclear cells with the acinar arrangement of the low columnar cells in the center of the field. (×400.)

On admission to Mount Zion Hospital on July 27, 1939, the pelvic examination showed a hard, slightly movable tumor lying between the rectum and the bladder and occupying the entire pelvis. It could be palpated abdominally just below the umbilicus. The tumor seemed separate from the small, atrophic uterus, which appeared to be compressed by the overlying tumor mass. Fluoroscopy of the chest showed fluid in the right chest, extending to the axilla, with displacement of the heart to the left.

At consultation at this time between the patient's physician and the senior author (F. I. H.), it was suggested that there might be a relationship between the pelvic tumor and the pleural effusion, that this patient might represent a case of Meigs' syndrome. The decision was made to aspirate the fluid from the chest and to study

it microscopically. If no evidence of malignancy of the lung could be found in the centrifuged fluid, the patient was to be subjected to a laparotomy on the tentative diagnosis of ovarian fibroma producing the pleural effusion.

Thoracentesis was performed on July 27, 1939, and 3,000 c.c. of fluid aspirated from the right chest. This fluid on examination showed a yellowish, turbid color; specific gravity, 1.018; Rivolta test, slightly positive; red blood count, 360; white blood count, 740; with a differential count of lymphocytes, 77 per cent; large endothelial cells, 12 per cent; polymorphonuclear leucocytes, 9 per cent; monocytes, 2 per cent. The Gram stains showed no organisms. Guinea pig inoculations were done and were later reported to be negative. The fluid was centrifuged and the sediment dehydrated and embedded in paraffin.

G. Y. Rusk, pathologist at Mount Zion Hospital, reported that microscopic examination of this sediment revealed it to be composed of a mixture of large mononuclear cells, lymphocytes, and a few polymorphonuclear leucocytes. The large cells had a distinct oval or round vesicular nucleus that contained a small nucleolus and a fine network of chromatin strands. There were no mitotic figures. There was one nest of cells which differed from the above in that it contained low columnar cells in a distinct acinar arrangement with the nuclei arranged in a row in the midportion of the cells. There were no mitoses in these cells.

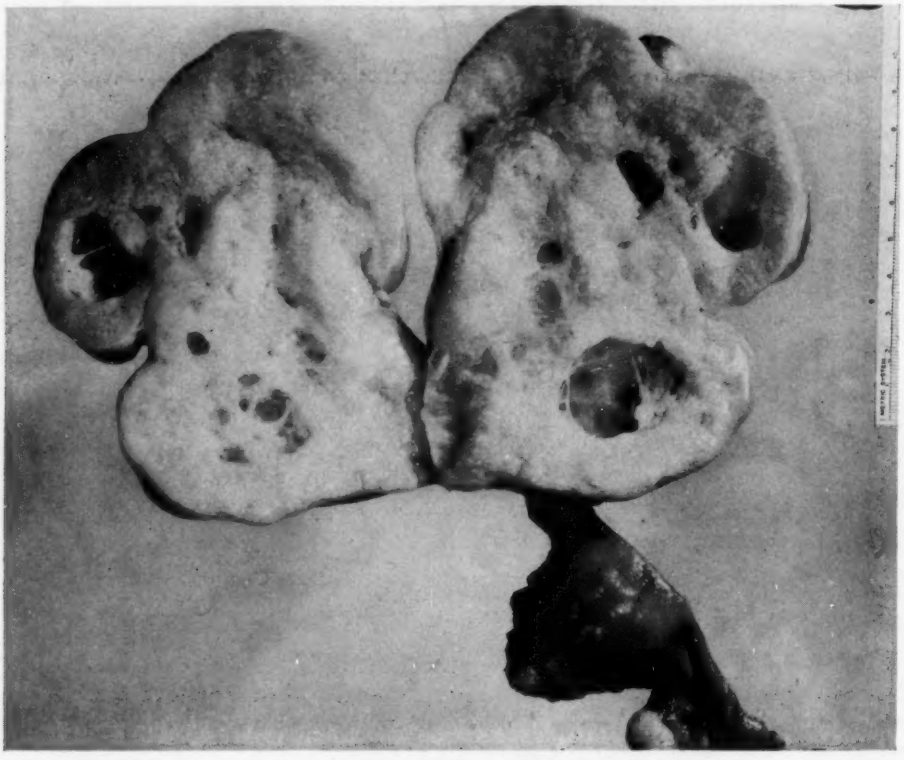

Fig. 3.—Photograph of cut section of ovarian fibroma (left) with the attached atrophic uterus and right ovary.

Pathologic Diagnosis.—Sediment of pleural fluid composed of mesothelial cells, lymphocytes, and polymorphonuclear cells with one acinar formation of low columnar cells (Fig. 2).

Operation.—On Aug. 1, 1939, under subarachnoid anesthesia, a midline incision was made, and the peritoneal cavity opened. There was noted about 200 c.c. of clear,

straw-colored, ascitic fluid. In the region of the left ovary there was a large, irregular, nodular mass, which was firm to palpation, of a whitish color with reddish streaks throughout its surface. The uterus was small and atrophic, and on its anterior surface there were two very small, seedlike, subserosal, whitish areas. The right ovary was small and atrophic. The mass described on the left side was slightly adherent to the parietal peritoneum posteriorly. It was easily freed up and removed, together with the uterus and right ovary. The liver was palpated and visualized and appeared essentially normal. Complete intra-abdominal exploration was negative for any evidence of metastatic nodules or enlarged lymph glands. The exploration was considered essentially negative in all respects, except for the tumor described.

The postoperative course of this patient was essentially uneventful. Her recovery was rapid and complete. At the present time, six months after her operation, she has gained weight and strength, and repeated fluoroscopic examinations of her chest have shown no evidence of a return of the pleural effusion. She states that she is enjoying the best health she has had in the last few years.

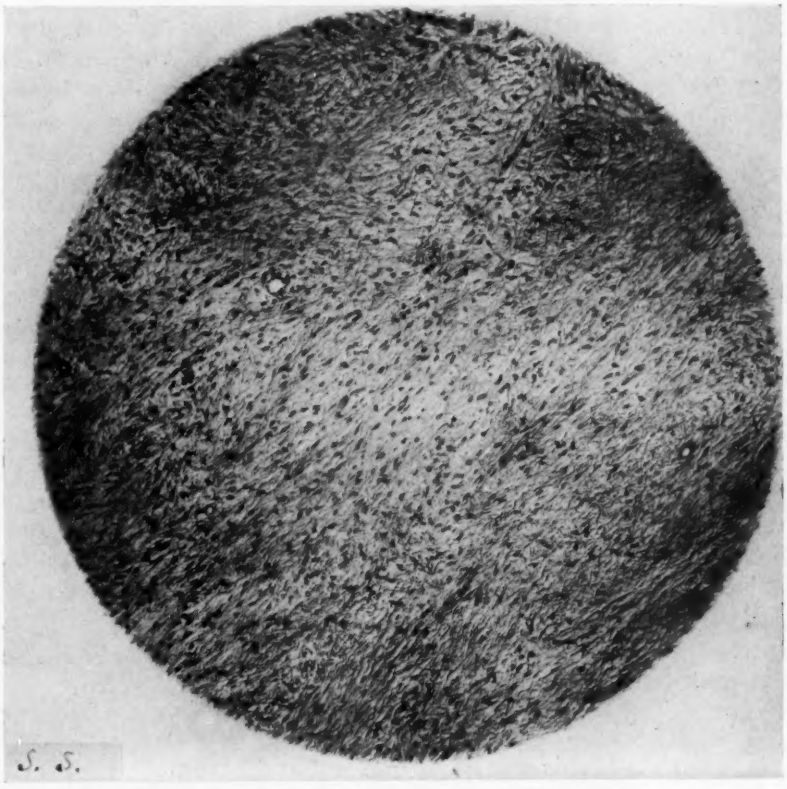

Fig. 4.—Photomicrograph of ovarian fibroma. The collagenous fibrils are loosely arranged with a slight tendency toward a fascicular formation. (×100.)

Pathologic Examination (by Dr. G. Y. Rusk).—"The specimen consists of a uterus, both tubes, the right ovary and a large, lobulated mass in place of the left ovary (Fig. 3). This large, irregularly lobulated, firm gray mass measures 13 by 10 by 6 cm. in its three dimensions. It has entirely replaced the left ovary and at the point of attachment of the tube no ovarian tissue is recognizable. The lobulations vary from 3 to 9 cm. in size, and there is a thin, smooth capsule covering them. On hemisection there are several large cysts measuring up to 4 cm. in diameter situated in the center of some of the larger lobulations. The cysts are lined by a

grayish smooth tissue. The lobular arrangement can be distinguished on cross section and these lobules are demarcated by the fine grayish strands. The parenchyma has a slightly yellowish color, and fine septal-like strands of gray tissue interlace in the yellowish parenchyma. The uterus is 4.5 cm. long. The surface is normal. On cut section the endometrial cavity is small, but the endometrium is distinct. The myometrium contains one large circumscribed mass 1 cm. in diameter and multiple small nodules ranging from 2 to 4 mm. in diameter. It has a striated appearance. The tubes are normal. The right ovary is small, measuring 2.5 by 1.25 by 1 cm. The surface is smooth, and on section an occasional small white scar is noted. There are no cysts of corpora lutea.

"Blocks of tissue are fixed in Zenker's fluid with acetic acid, and 10 per cent formalin.

"Microscopic examination of the ovarian tumor shows it to be composed of fibroblasts arranged in bundles and fascicles (Fig. 4). In some regions the cells are compactly placed; whereas, in other parts they are loosely arranged. The nuclei are long and slender and have diffusely scattered small chromatin granules and fine chromatin threads. An occasional mitotic figure is present. The cells in compact regions are not clearly outlined. Fine collagenous fibrillae are present between the nuclei. In the less compact areas the nuclei are separated by fibrillae, in some places tightly packed, in other places loosely arranged. Small vascular channels are present throughout. The capsule of the tumor is composed of laminated layers of collagen. Connective tissue stains, particularly Mallory's phosphotungstic acid hematoxylin and Mallory's acid fuchsin aniline blue, bring out the collagenous nature of the fibrillae of the cells of the tumor.

"Sections of the tubes show no significant alterations. On the peritoneal surface there are several minute epithelial-lined cysts which are probably embryonic remnants. Sections of the other ovary show a compactly arranged cortical stroma with no primordial follicles. There are a few scattered corpora albicantia deep in the medullary portion.

"Sections of the uterus show a thin irregular endometrium composed of glands that vary in size, shape, and location. Many are cystic; others have the ordinary tubular form. The stroma is compact and fibrous. Throughout the myometrium are islands of endometrial stroma and epithelial lined glands. There is a diffuse increase in interstitial fibrous tissue. The combination of the endometrial islands and increased fibrous tissue stroma produced the striated gross appearance of the uterus."

Diagnosis.—(1) Fibroma of the left ovary, (2) atrophy of the right ovary, (3) normal tubes, (4) adenomyosis of the uterus, single leiomyoma of the uterus, atrophy of the endometrium.

COMMENTS

Certain aspects of this case are of interest and have not been previously emphasized in connection with this unusual syndrome. The microscopic findings of the centrifuged pleural fluid (Fig. 2), showing a distinct nest of cells in acinar arrangement, may be of significance in relation to the unexplained problem of why pleural effusion occurs in these ovarian fibromas.

The fact that this patient had been given a thorough course of radiation therapy to her pelvis on the assumption that the tumor was a uterine fibroid would tend to show the ineffectiveness of radiation therapy as treatment for a benign fibroma of the ovary.

That these cases may be wrongly diagnosed as growing uterine fibroids is emphasized by our experience with this patient. A point of differentiation which may be helpful in other future cases is the fact that seldom, if ever, have we seen or heard of uterine fibroids developing and growing after the menopause. As ovarian fibromas on pelvic examination feel to the examining hand exactly like uterine fibroids, the preceding statement may be of considerable help in differential diagnosis.

SUMMARY AND CONCLUSIONS

A case is reported of a woman 67 years of age, who had been known to have a growing pelvic tumor diagnosed as a uterine fibroid for four years. She developed massive pleural effusion in her right chest, which was thought to be due to a malignancy. Abdominal operation and removal of a large benign ovarian fibroma resulted in a complete restoration to health, with no recurrence of the pleural fluid.

Based on the experience in this sixteenth reported case of Meigs' syndrome, it is our opinion that an ovarian fibroma producing pleural effusion does not respond to radiation therapy and is best treated by surgical extirpation.

Differentiation must be made between uterine fibroids, metastatic malignancy, and ovarian fibromas in the diagnosis of this condition. A correct differential diagnosis may mean restoration to health of a patient who is doomed as hopeless.

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CASE OF POSTOPERATIVE PELVIC ENTEROCELE AND UTERINE PROLAPSE

ROBERT T. FRANK, M.D., AND RALPH COLP, M.D., NEW YORK, N. Y.
(From the Surgical and Gynecological Services of the Mount Sinai Hospital)

A UNIQUE traumatic perineal enterocele, complicated by prolapse of the cervix with eversion of the vagina, developed in the course of treatment in a patient in whom a rectal carcinoma had been operatively removed. The condition itself is of interest because of its rarity. The major interest, however, centers in the final operative cure of the condition, because of the many anatomical defects and technical complications which had to be overcome.

CASE REPORT.—Mrs. P. S., aged 52 years, gravida iv, para iii, a widow, was admitted to the Mount Sinai Hospital, on the service of one of us (R. C.). For thirty-four years she had suffered from bloody stools and diarrhea. Nineteen years previously an appendicostomy was established for treatment of the large bowel. Eleven years ago the opening closed spontaneously. This was followed by intestinal obstruction in a postoperative ventral hernia and was relieved by operation.

The present history shows a continuation of the bloody stools and diarrhea. There was a loss of ten pounds and recently also oligomenorrhea.

Physical examination showed a large, obese woman. The lower abdomen was occupied by a solid mass. Rectal examination showed an annular constriction of the rectum, above the sphincter ani. The heart, lungs, and kidneys appeared normal. Biopsy from the rectum showed an infiltrating carcinoma.

First Operation, First Stage Lahey (R. C.) (April 15, 1936).—The sigmoid was divided between clamps. A permanent colostomy was established in the left rectus muscle, the end of the distal sigmoid loop implanted through a suprapubic stab wound. At this operation it was found that the liver and abdomen showed no signs of metastases. A fibroid uterus which filled the pelvis was left undisturbed.

Second Operation, Perineal Resection (R. C.) (April 30, 1936).—The coccyx was removed. The posterior cul-de-sac was opened. A considerable portion of the adherent posterior vaginal wall was resected with the involved lower sigmoid, rectum, and anus. The distal end of the isolated sigmoid loop was closed and buried in the perirectal cavity. Liberal pelvic drainage.

The patient was seen by one of us (R. T. F.) on May 18, 1936, because of a huge vaginal eversion behind the perineum, which was represented by a mere tissue bridge. She was admitted to the Gynecological Service (R. T. F.) on Jan. 10, 1937. Behind the perineal skin bridge was the prolapsed and everted vagina with a hypertrophic cervix and below this the traumatic enterocele. The prolapse occurred through the area which had previously represented the perineal body, anus, and retroanal tissue. (Fig. 1*A*.)

Third Operation, Sigmoidectomy of Residual Sigmoid, Supravaginal Hysterectomy for Fibroids (R. C. and R. T. F.) (Jan. 15, 1937).—The suprapubic stoma which represented the upper end of the remaining sigmoid was circumcised and freed. The peritoneal cavity was opened widely and a supravaginal hysterectomy of a uterus, enlarged by multiple fibroids to the size of a three and one-half months' pregnancy, was performed, the section being high in order to preserve a

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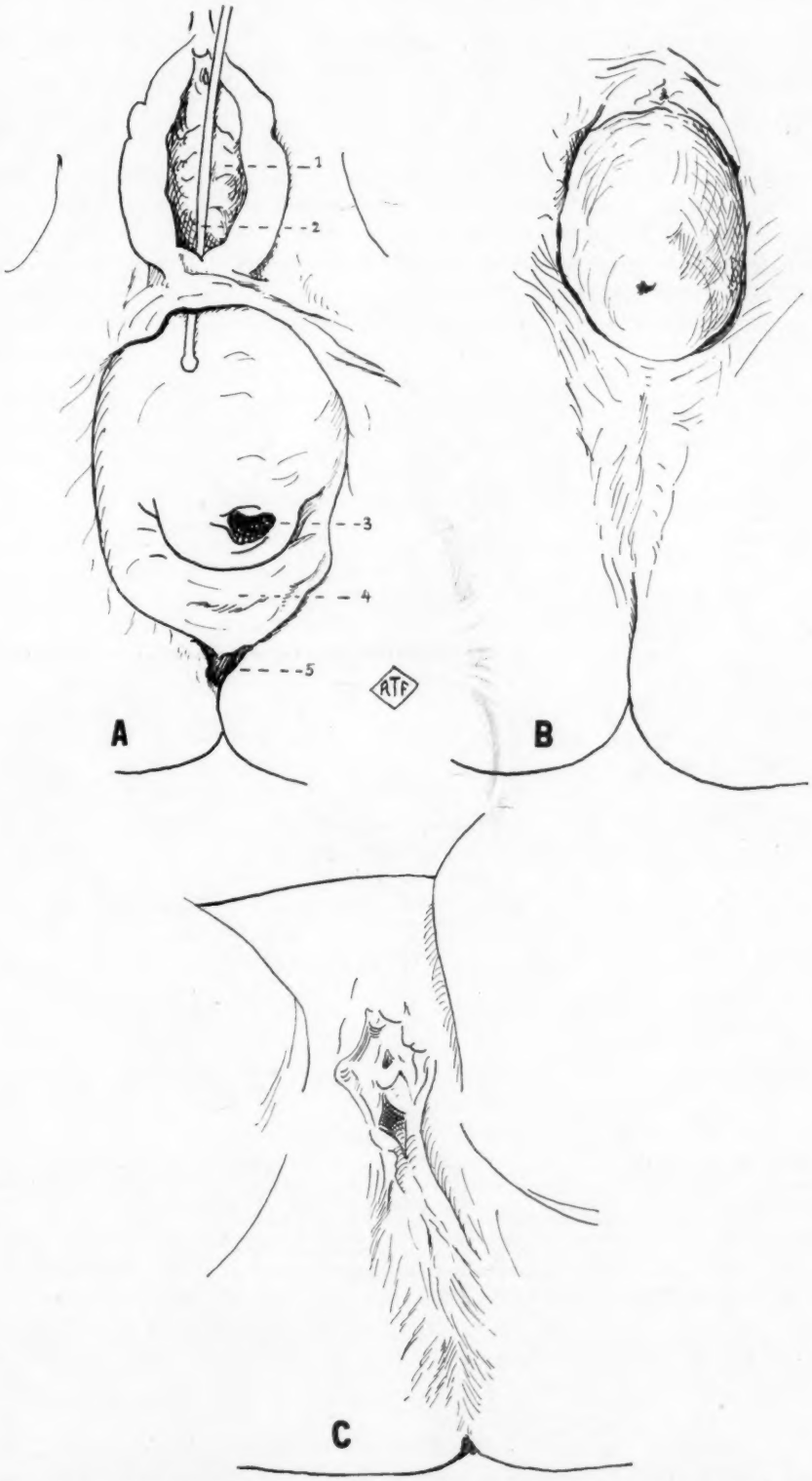

Fig. 1.—View in lithotomy position. *A*, prolapse and enterocele after second operation: *1*, anterior vaginal wall; *2*, probe inserted under skin bridge representing remains of perineum; *3*, prolapsed cervix (external os); *4*, posterior traumatic enterocele; *5*, skin opening of sinus tract. *B*, Condition after fifth operation: Enterocele cured. Prolapse of cervical stump and eversion of vagina. *C*, Final result with patient straining. (Redrawn from photographs.)

long cervical stump. Both adnexae were removed and the cervical stump completely peritonealized as in a typical supravaginal hysterectomy.

The residual sigmoid loop was then completely freed, the pouch of Douglas opened, the sigmoid pushed into the extraperitoneal pelvic cavity, and the peritoneum of Douglas' cul-de-sac reclosed over the bowel. With the patient now in lithotomy position, the sigmoid was completely removed through the reopened perineal incision. A long fistulous tract was excised and the cavity packed.

As the patient had shown no signs of recurrence of the cancer in one year and as the prolapse incapacitated her, a reparative operation was decided upon.

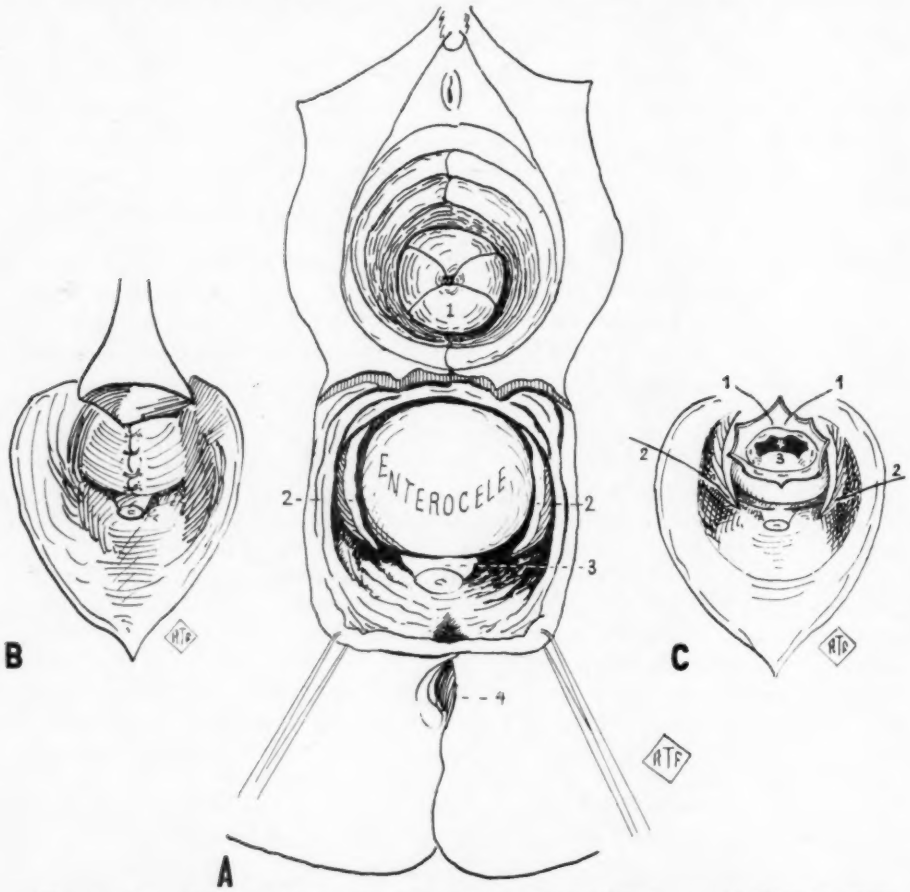

Fig. 2.—Operative procedures (fourth and fifth operations). *A*, Manchester operation completed. Enterocele exposed: *1*, amputated cervix; *2*, edges of levators previously resected at Operation 2; *3*, lower end of sacrum; *4*, skin opening of sinus tract. *B*, Levator edges united by suture in Operations 4 and 5. *C*, Enterocele sac opened (Operation 5): *1*, ends of pursestring suture used for reclosing hernial sac; *2*, ends of lowest levator suture passing through periosteum of sacrum; *3*, promontory of sacrum shining through peritoneum of Douglas' pouch; *4*, upper peritoneal cavity; the cervical stump is situated above *4*.

Fourth Operation, Manchester Operation for Prolapse, Repair of Traumatic Posterior Enterocele (R. T. F. and R. C.) (April 5, 1937).—The perineal skin bridge was cut, the bladder freed, and a typical Manchester operation performed with repair of the posterior vaginal wall.[1]

After this stage had been completed and the cervix had receded upward, a transverse incision behind the vagina was made and the subperitoneal pelvic cavity widely opened. The previously partly resected (at Operation 2) levator ani plates were visualized where they had retracted upward and laterally. (Fig. 2*A*.) On

both sides they were freed by blunt dissection and sutured together in the median line behind the vagina (Fig. 2*B*). The lowermost suture was passed through the periosteum of the anterior surface of the sacrum (as shown in Fig. 2*C*, *2*). Residual granulation tissue was removed and a new high "perineum" built up with whatever tissues could be brought together. Posteriorly a gauze drain was inserted to the tip of the sacrum through the skin opening of the fistulous tract. (Fig. 2*A*, *4*.)

Soon after operation a recurrence of the posterior bulge was noted and the cervical stump prolapsed one and one-half inches beyond the vulva. The hernia contained intestine, as could be ascertained by the presence of tympany and intestinal gurgle.

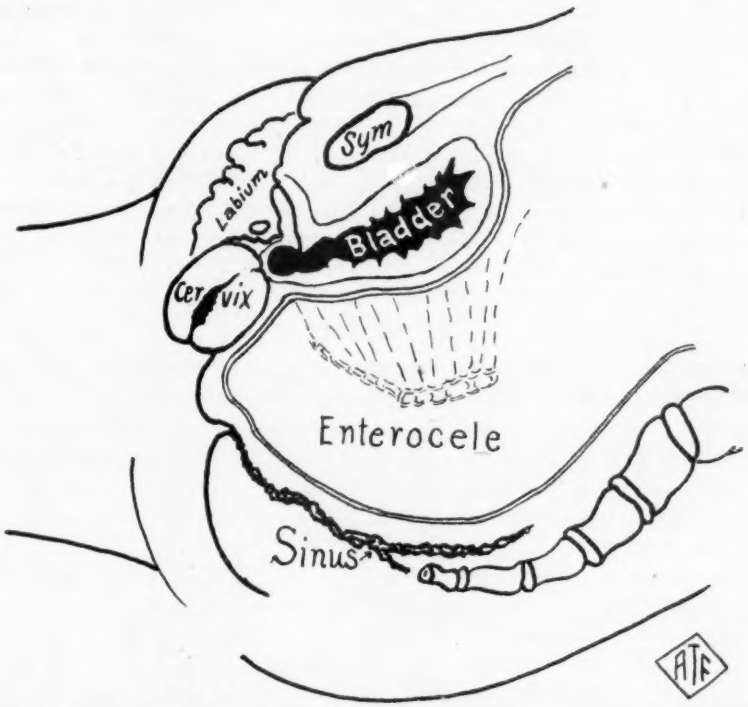

Fig. 3.—Schematic saggital section of pelvis showing condition before Operation 5. The broken lines indicate position of right half of the partly resected levator plate as viewed through peritoneum and endopelvic fascia.

Fifth Operation, Plastic Repair of Enterocele (R. T. F.) (June 15, 1938).*—A semilunar transverse incision was made behind the vagina. The posterior vaginal wall was separated, mainly by sharp dissection, from the protruding hernia. The peritoneal sac which now was the size of a fetal head, was dissected free from the dense scar anchoring it to the pelvic walls. On opening the huge sac, the posterior surface of the cervical stump and the base of the parametria were visualized. After reducing the protruding small intestine upward, the sac was tied off high up by a circular chromic suture, including anteriorly the posterior surface of the cervical stump, laterally the endopelvic fascia, and posteriorly the peritoneum and fascia along the posterior surface of the Douglas' cul-de-sac. (Fig. 2*C*.) The levator plates were again brought together below the peritoneum although the approximation entailed greater tension than at the previous operation (Fig. 2*B*). Below the levator sling all available tissue was again approximated in the median line. A posterior drain was inserted through a lateral stab wound. Fig. 3 is a schematic sagittal section showing the condition before this operation.

The result in regard to the enterocele was good, but a new eversion of the vaginal walls with prolapse of the cervical stump developed (Fig. 1*B*). This incommoded the patient greatly. The patient, who is a widow, gave her consent for a complete colpectomy.

Sixth Operation, Colpectomy and Coring Out of Cervical Stump (R. T. F.) (Oct. 12, 1938).*—The cervical canal was cored out. The flat portio was denuded of mucosa as it was considered essential to leave as much cervical tissue as possible, because the closure of the peritoneal sac at the previous operation was effected partly with these tissues. The vaginal mucosa was removed to within one inch of the urethral meatus and the vaginal canal obliterated by successive layers of circular sutures.

Re-examination of the patient Jan. 12, 1940, three and one-third years after the primary operation, shows a firm perineum without bulge, a functioning left abdominal colostomy, the patient symptomatically and anatomically well (Fig. 1*C*).

This unusual combination of conditions necessitated six operations for complete re-establishment of health. Before operation the size of the fibroids had prevented a prolapse of cervix and vagina. Excision of the rectum produced marked weakening of the pelvic supports and after hysterectomy, which was essential to permit approach for sigmoidectomy, complete prolapse of the vagina and cervical stump followed. The radical operation required for excision of the carcinoma necessitated division and partial excision of the pelvic diaphragm and thus permitted the huge enterocele to develop.

REFERENCE

1. Frank, R. T.: "Parametrial Fixation" (Manchester Operation) for Prolapse of the Uterus, Am. J. Obst. & Gynec. **29**: 240, 1935.

*I (R. T. F.) desire to thank Dr. I. C. Rubin for having extended the courtesy of the Gynecological Ward to me for performing the last two operations.

THE INDICATION FOR SPLENECTOMY IN THE ASSOCIATION OF ANEMIA AND SPLENOMEGALY

ABRAHAM O. WILENSKY, M.D., NEW YORK, N. Y.

THE presence of an impoverished condition of the blood is a very common one in clinical medicine. Under certain conditions hypochromic anemia is associated with various grades of enlargement of the spleen and in a certain proportion of the latter another factor becomes apparent which is associated with hemolytic destruction of the red blood cell.

Hemolytic destruction of the red blood cell is not always due to the same factor nor always are the same laboratory evidences present in cases which apparently possess very similar clinical manifestations. Three groups of cases are clinically discernible based upon the reaction of the patient to splenectomy.

Group 1. Cases in Which the Indication for Splenectomy Is Sharply Defined and in Which a Permanent Good Result ("Cure") Can Be Expected.—

CASE 1.—A 37-year-old nulliparous female of German birth was admitted on April 14, 1939, because of a progressively increasing menorrhagia of six months' duration, characterized by a gradual lengthening of the menstrual periods from three to fourteen days. She had not observed bleeding from any other part of her body. Even though the appetite was good and there was a sense of well-being, there was a loss of eight pounds in weight. There was no history of tuberculosis, syphilis, malaria, etc.

The previous history was as follows: In September, 1938, the patient returned from a trip to Germany, where she had been subjected to a restricted food diet, because of the rationing system that prevailed. She then visited her family physician because she had noticed a loss of weight and an "anemia." He called her attention to the jaundice which had hitherto not been observed; he was also able to feel a slightly enlarged spleen. Hematologic studies were made on several occasions, including study of the bone marrow, and showed a severe grade of hypochromic anemia, a reticulocytosis, and a spherocytosis; preponderating normoblasts were present in the bone marrow. "There is no doubt that the patient has a congenital hemolytic icterus" (report of Dr. Rosenthal).

In April, 1939, her family physician again saw the patient, at which time there was no subjective or objective relief or subsidence of the symptomatology.

The physical examination on admission revealed a 37-year-old white female, well nourished and not appearing acutely ill. The positive findings were as follows: (1) slightly icteric sclerae; conjunctivae and mucous membranes relatively pale; (2) systolic murmur at the apex; blood pressure, 140/90; (3) a spleen that was enlarged to three fingerbreadths below the left costal margin; (4) no evidence of lymphadenopathy; (5) vaginal examination was essentially negative.

We were all agreed that the patient had a congenital hemolytic icterus and, since the general condition of the patient was eminently satisfactory and she seemed to be in a latent stage, splenectomy seemed indicated.

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On April 8, 1939, I explored the patient under avertin-gas-oxygen anesthesia and found the following: a markedly enlarged spleen, an absence of any accessory splenic tissue, a normal appearing liver, an extrahepatic biliary tract which was normal to palpation, no fluid in the abdominal cavity, normal pelvic organs with the exception of an immaterial, slight cystic condition in one ovary. Specimens of blood were aspirated from the splenic artery and the splenic vein for study. A rather easy splenectomy was done; a biopsy of the liver was taken from its left lobe and the abdominal wound was then closed without drainage.

Even though the patient bore the operation very well, a transfusion of 500 c.c. of blood was immediately given by the citrate method. Thereafter the patient made an uninterrupted and uneventful recovery and was discharged from the hospital thirteen days after operation.

We inquired carefully into the family history and discovered that the patient had one brother living in Germany who seemed to have a somewhat similar condition, for which, recently, he has also been operated upon.

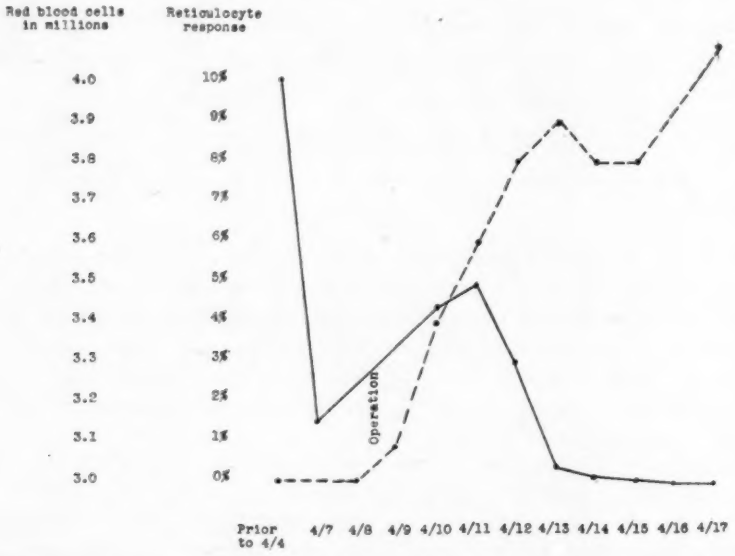

Fig. 1.—Red blood cell and reticulocyte response preoperatively and postoperatively.

An analysis of the diagnostic hematologic work-up shown in Table I and Fig. 1 is as follows: (1) The correction of the hypochromic microcytic anemia to the normal; (2) diminished cell volume in the blood; (3) temporary persistence of microcytosis after operation; (4) normal platelet counts; (5) disappearance of the reticulocytosis after operation; (6) the persistence but lessening of the fragility of the red blood cells after operation; (7) the slight leucocytosis which was present after operation; (8) normal blood chemistry, bleeding and coagulation times; prothrombin time slightly increased; (9) a direct and indirect van den Bergh indicating both obstructive and nonobstructive elements; bromsulphalein test indicating some liver damage; (10) a relative equality of the bilirubin value for blood from the splenic artery and vein; (11) disappearance of urobilinogen present before operation.

Comment.—Hemolytic jaundice is an inherent, usually familial disease which occurs at any age or in any sex or race and which has no geographic limitations. The basic pathologic change occurs in the red blood cells. They are different in size and shape; are smaller, thicker, and spherical; and the cell assumes a biconvex appearance in contrast to its normal biconcave morphology. These microspherocytes are so typically diagnostic of this condition that the latter is referred to, at times, as "microspherocytosis." The spherocytes are as typical of this condition as the sickle cells are in sickle-cell anemia. The cells are peculiar in that they possess none of the natural ruggedness of the normal biconcave red blood cell and so account for the demonstrable fragility of the latter cell, which becomes one of the diagnostic features of this disease.

No satisfactory explanation exists as to the cause and biologic mechanism of this affliction. It is known that it is more severe on successive transmissions and limited by the death of the more severe types. There are cases in which people possessing a peculiar yellow pallor are vigorous throughout life, but can nevertheless transmit the disease. Splenectomized individuals of this type can transmit the disease.

The splenomegaly is a secondary change which accompanies the increased destruction of red blood cells: the latter leads to a hyperactive bone marrow and an increase in the erythropoietic tissue, and to an outpouring of reticulocytes as well as the granulopoietic elements or leucocytes. The increased destruction of red blood cells explains the higher values of serum bilirubin obtained from the splenic vein as compared to that from the splenic artery. When the demand upon the bone marrow has exceeded its normal capabilities, the bone marrow emits normoblasts, nucleated red blood cells, and immature white blood cells into the circulating blood. This may occur in the presence of infection and a pre-existing hemolytic icterus and is regarded as a "bone marrow crisis" and, clinically, as an acute phase.

The subjective and objective symptomatology results from all of these factors. A number of patients enjoy good health and a normal life and the condition is only detected in the course of a routine examination. Some cases present themselves to the physician because of a "yellow color"; others because of symptoms resulting from anemia or weakness, cold extremities, palpitations, menorrhagia, etc.; or because of the splenomegaly, there are abdominal pains and dragging sensations.

In all typical cases the laboratory findings are conclusive and are as follows: (1) Increased fragility of the red blood cells (normally 0.42 to 0.34 complete; hemolytic anemia, 0.48 to 0.42); (2) variable anemia (3.0 M. to 1.0 M.); (3) color index below 1; (4) a volume index which is normal, or slightly below normal, since the thickness of the red blood cells compensates for any diminution of its size; (5) leuco-

TABLE I

DATE	PLATELETS	% HEMOGLOBIN	RED BLOOD CELLS	LEUCOCYTES	POLYMORPHONUCLEARS SEGMENTED	LYMPHOCYTES	BAND FORMS	MONOCYTES	FRAGILITY TEST OF RED BLOOD CELLS*	RETICULOCYTES	MISCELLANEOUS
Blood (Preoperatively)											
11/11/38	310,000	56	3,020,000	5,700	59	28	4	6		Less than 0.5%	Microcytosis observed
11/17/38	320,000	63	3,080,000	9,200	64	26	3	7		10%	Spherocytes observed
1/ 4/39		69	4,100,000						P.H., 0.48%-0.44% C.H., 0.4% NaCl		Many nucleated red blood cells
4/ 4/39	220,000	62	3,140,000	5,400	85	13	1	1			Microcytosis observed
4/ 7/39	170,000									1.5%	Cholesterol, 196.1; cholesterol esters, 0.11.1 or 57% of total; direct van den Bergh, biphasic; indirect van den Bergh, 2 units per 100 c.c.; prothrombin time, 210 seconds (200 is normal); blood chemistry normal; quantitative bilirubin: splenic artery, 3.7 units per 100 c.c. of serum; splenic vein, 3.7 units per 100 c.c. of serum; bromsulphalein test, 15% retention in one-half hour; urobilinogen positive in 1:40 dilution

1/ 4/39											Bone marrow: White blood cells, 144,000; megakaryocytes, 66; myeloblasts, 5%; myelocytes neutrophiles, 15%; polymorphonuclears staffs, 6%; polymorphonuclears eosinophiles, 2%; polymorphonuclears basophiles, 1%; polymorphonuclears segmented, 3%; hematogones, 14%; normoblasts, 48%; erythroblasts, 5%; monocytes, 0%; plasma cells, 1%
Postoperative Laboratory Data											
4/ 8/39	440,000	60	3,000,000	10,600	86	9	4	1	P.H., 0.40% C.H., 0.36%		
4/ 9/39		68	3,090,000	18,500	85	10	5				
4/10/39	280,000	67	3,460,000	17,200	79	15	3			4.5%	Icteric index, 10.1
4/11/39	290,000	70	3,600,000	18,400	82	7		11	P.H., 0.40% C.H., 0.38%	5.0%	
4/12/39	340,000	74	3,800,000	16,400	80	12	1	6		3.2%	
4/13/39	330,000	74	3,900,000	10,700	67	18	2	11		0.4%	
4/14/39	320,000	74	3,800,000	8,800	68	21		10		0.1%	
4/15/39	480,000	74	3,800,000	13,800	74	14	3	8		Not seen	
4/17/39	480,000	80	4,300,000	12,500	78	8		12		Not seen	

cytoses; (6) reticulocytoses (may go as high as 50 per cent); (7) microcytoses; (8) spherocytosis (this is diagnostic).

Of all of these factors the outstandingly important one concerns the physical characteristics of the red blood cell; that is, the spherocytosis. This does not occur in all cases of hemolytic icterus, but when it does occur it forms the positive indication for splenectomy. However, in any "crisis" conservative treatment, including iron, high caloric diet regulation, and repeated transfusions, is temporarily indicated. The splenectomy, nevertheless, should be done only in latent periods and after due preparation. In successfully splenectomized cases the results are spectacular and show at once. The operative result is followed by what is, in effect, a permanent remission of the disease since microcytosis, sphericity, and the increased fragility of the red blood cells may persist. However, marrow activity is decreased, a rise in the hemoglobin and a rise in the red blood cell count level occur with a diminishing reticulocytosis until a normal cellular level is obtained.

CASE 2.—In a young male patient, 17 years of age, there was a history of severe post-tonsillectomy hemorrhage ten years previous to the present admission followed at later times by severe hemorrhage after the extraction of teeth, episodes of severe epistaxis, and the appearance of recurrent bleeding red spots on the fingers of the right hand. The patient was admitted because of uncontrollable hemorrhage from the nose of three days' standing.

Except for cutaneous purpura, the physical examination was essentially negative. The laboratory hematologic work-up is shown in Table II.

The hematologic diagnosis was: Thrombocytopenic purpura hemorrhagica. As the patient was in a chronic phase of the affliction, splenectomy was advised and performed. The operative findings included a somewhat enlarged spleen and a small accessory spleen; both of these were removed.

The postoperative laboratory hematologic observations are also shown in Table II.

There was no further bleeding of any kind after the splenectomy, the patient made an uneventful convalescence and was discharged from the hospital "well."

The patient has been followed since then. There has been no further tendency to bleed. He has gone through operations for subacute appendicitis and for the removal of a pilonidal cyst without any difficulty. Several times he has been readmitted to the hospital for episodes of unclassifiable abdominal pain without any signs of bleeding, from all of which there has been spontaneous and satisfactory recovery.

Comment.—In cases of thrombocytopenic purpura hemorrhagica of congenital origin and/or of long standing the demonstrable depletion of the platelets is the indicating sign for splenectomy. In the acute or critical periods of the disease splenectomy is ill advised and is sometimes followed immediately or within a relatively short time by a fatality. Splenectomy is indicated only in the long-standing chronic cases and should be done if possible in periods of remissions; nevertheless, it is also unsurpassed as a method of hemostasis in critical periods of bleeding.

TABLE II

DATE	PLATELETS	% HEMOGLOBIN	RED BLOOD CELLS	WHITE BLOOD CELLS	POLYMORPHONUCLEARS SEGMENTED	POLYMORPHONUCLEARS NON-SEGMENTED	LYMPHOCYTES	MONOCYTES	BASOPHILES	EOSINOPHILES	BLEEDING TIME IN MINUTES	COAGULATION TIME IN MINUTES	RETICULOCYTES	TRANSFUSIONS (CITRATE) C.C.	MISCELLANEOUS
12/ 2/32											8	5			Urine: rare R.B.C. Tourniquet test: positive Wassermann: 3+ Kahn: negative Stool: guaiac 4+
12/ 4/32	56,000	75	3,900,000	11,500	62	8	20	9					0.5%		
12/ 6/32		70													
12/11/32															Urine: rare R.B.C.
12/12/32	40,000	72									22				Stool: guaiac trace
12/16/32															Urine: negative
12/17/32	Operation: splenectomy													500 c.c.	
12/18/32		70	3,800,000								13	4			
12/26/32	210,000	59	3,010,000	18,200	59	20	6	10		3			6.0%		Myelocytes: 2 Myeloblasts: 1 Normoblasts: 1 Slight stippling of red cells
12/30/32															
1/30/33	720,000	85	4,900,000	9,200	63	1	31	3	0	2	2	5	1.5%		Urine: negative Color index: 0.86 Tourniquet test: negative Clot retraction: active
8/30/37															Urine: negative
9/ 8/37	410,000														Wassermann: negative

Cessation of all bleeding in properly selected cases is to be immediately expected and does occur; and, when no other supply of splenic tissue exists, cessation becomes permanent. The importance of looking for and removing all accessory splenic tissue is, therefore, paramount, and the unfortunate heedlessness, default, or omission of the removal of the latter probably accounts for all cases of failure after splenectomy done for this indication.

In such cases, of which the described case is a good example, the defect is unassociated with any other form of demonstrable pathology, the clinical concept of thrombocytopenic purpura hemorrhagica becomes a self-contained and sufficient entity, and recovery becomes permanent.

Group 2. Cases in Which the Indication for Splenectomy Is a Symptomatic One and Is Justifiable in Order to Relieve the Tendency to Bleed, but in Which the Underlying Disease Is Uninfluenced by the Removal of the Spleen.—

CASE 3.—A young man of Italian parentage, whose grandfather is said to have had similar bleeding episodes, came to the hospital with the history that from the age of 6 years he had been subject to: (1) frequent epistaxis lasting several hours, especially in winter; (2) alarming episodes of bleeding lasting from two to three days following any tooth extraction; (3) very excessive ecchymosis following even slight trauma; (4) overprominent abdomen, as a child causing his friends to call him "sparrow belly."

Because of these symptoms he was studied at another hospital about six months previously where a diagnosis of purpura hemorrhagica was made. Radiologic studies made at that time showed no changes in the long bones or in the skull. Except for this bleeding tendency the patient has had no symptoms of any kind referable to any part of the body, and he has continued to look relatively well up to the present time.

Several months ago following trauma to the thigh an especially large subcutaneous hemorrhage developed and because of this and because of continuing nosebleeds and because he himself felt a mass in the abdomen he came to the hospital for treatment.

The patient was a tall, thin, pale, light olive complexioned man whose general physical examination was essentially negative. There was no enlargement of the lymph glands anywhere in the body. No petechiae or ecchymosis were visible and there was no evidence of bleeding about the gums. In both of the eyes there was a slight heaping-up of the conjunctiva, suggestive of a pinguicular formation. There was a soft systolic murmur at the apex.

The entire left half of the abdomen was occupied by a large nontender mass which was evidently a greatly enlarged spleen. The liver was palpable about one-half inch below the costal margin. There was no ascites.

Under diagnosis of thrombocytopenic purpura I explored the patient and noted the following: no excess bleeding on entering the abdomen; no ascites; the spleen occupied the entire left half of the belly and a small accessory spleen about one-half inch in diameter was present near the tail of the pancreas. Except for some enlargement, the liver looked normal. No enlargement of the abdominal lymph nodes

TABLE III

DATE	PLATELETS	% HEMOGLOBIN	RED BLOOD CELLS	WHITE BLOOD CELLS	POLYMORPHONUCLEARS	EOSINOPHILES	BASOPHILES	BAND FORMS	LYMPHOCYTES	MONOCYTES	BLEEDING TIME IN MINUTES	COAGULATION TIME IN MINUTES	PROTHROMBIN TIME IN MINUTES	TRANSFUSIONS (CITRATE) C.C.	MISCELLANEOUS
10/ 7/39	35,000	69	3,720,000	2,500	61		1	3	28	7	2½	4½	Normal		
10/ 9/39															Blood chemistry: normal Kahn and Wassermann tests: negative Bromsulfophthalein test: "no dye present in ½ hour"
10/10/39	Operation: 9:25 A.M.-10:00 A.M. (Procaine [spinal], 150 mg.)													250 c.c.	
Splenic artery	33,000	76	4,300,000	4,100	80		1		14	5		3	Normal		
Splenic vein	46,000	72	3,960,000	4,600	72			22		6		2	Normal		
11 A.M.	56,000			9,100	69			18	10	3					
2 P.M.	56,000			138,000	63			26	2	9					
4 P.M.														400 c.c.	
4:45 P.M.	50,000			13,200	62	1		26	4	7					
9 P.M.				11,200	78			10	12						
10/11/39		50	2,940,000	10,700	71			3	12	14					Poikilocytosis
10/12/39	220,000														
10/13/39	250,000														
10/14/39	420,000														
10/17/39	660,000	56	3,200,000	13,700	66	10		1	10	13					
10/20/39	540,000														
10/23/39	570,000														
10/24/39		Discharged													

TABLE IV

DATE	PLATELETS	% HEMOGLOBIN	RED BLOOD CELLS	WHITE BLOOD CELLS	POLYMORPHONUCLEARS	BAND FORMS	LYMPHOCYTES	MONOCYTES	BLEEDING TIME IN MINUTES	COAGULATION TIME IN MINUTES	STOOL	TRANSFUSIONS (CITRATE) C.C.	MISCELLANEOUS*
5/17/39	50,000	75	3,940,000	15,100	53	30	7	9	7	4	+		Reticulocytes: 0 Blood culture: negative
5/18/39	80,000	54	2,680,000	10,500	58	11	25	6	4	3½	+		Clotting retraction: normal Reticulocytes: 0.5 Spinal tap: negative Rumpel-Leede test: negative
5/19/39	24,000	38	2,210,000						6	3	+	300	Reticulocytes: 0 Moccasin venom: 0.1 c.c. of 1:3,000
5/20/39		43	2,440,000	3,200	60	12	20	8					
5/21/39		52	2,250,000	4,000	47	26	22	3					
5/22/39	50,000	44	2,210,000	3,900	57	4	20	14			+	250	
5/23/39	65,000	46	2,340,000	4,700	63	3	18	11	2½	3½	+		Moccasin venom: 0.2 c.c.
5/24/39	25,000	43	2,350,000	7,000	62	7	15	16			+	300	Spinal tap: negative except for sugar, 90.1 mg. %
5/25/39	20,000	40	2,180,000	11,400	76	3	12	8			+		Blood culture: sterile
5/26/39	60,000	38	2,180,000	14,600	76	2	13	8			+	300	

*Urine negative throughout.

5/27/39	60,000	52	2,620,000	12,300	77	7	12	4			+		Hippuric acid: 1.96 Gm. excreted
5/29/39	50,000	32	1,960,000	10,500	68	8	16	6			+	300	No parasites in stool
6/ 1/39	50,000	48	2,710,000	5,100	58	5	26	7			Neg.		
6/ 3/39	50,000	45	2,510,000	5,300	57	4	24	13					
6/ 6/39	110,000	55	3,500,000	8,500	48	3	32	14				300	
6/ 9/39	70,000	50	2,600,000	3,800	72		25	3			+		
6/12/39		60	3,350,000								+	300	
6/13/39	Operation: ethyl chloride-ether 2:25 P.M.-3:15 P.M.												
6/13/39	90,000	72	3,730,000										
4:15 P.M.	90,000	85		22,500	70	12	6	11				350	
	Splenic vein				28	6	53	6					Eosinophiles: 4 Basophiles: 1 Myelocytes: 1 Türck cell: 1
6/14/39	140,000	92		16,700	79	2	7	11					
6/16/39	180,000	88		17,300	81	2	8	8					
6/17/39	180,000	90		11,600	74	2	7	11					
6/18/39													Serum bilirubin: 0.5 u/100 c.c.
6/20/39	270,000	76		117,000									Blood culture sterile
6/23/39	280,000	84									+		
6/24/39													Blood smear negative for malaria
6/26/39	290,000	86									Neg.		
6/28/39	230,000	80											Blood smear negative for malaria
6/29/39		90	4,800,000	12,300	26	3	61						Blood culture sterile
6/30/39													Blood chemistry: glucose, 64.9; N.P.N., 26.5; uric acid, 3.5; creatinine, 1.21
7/ 3/39	440,000	86											
7/11/39	370,000	82											

was present. The spleen and accessory spleen were removed and a biopsy was taken from the liver. Specimens of blood were also taken from the splenic artery and splenic vein.

The patient made a very uneventful convalescence and was discharged from the hospital approximately two weeks after being operated upon.

Comment.—The entire hematologic laboratory work-up both before and after operation is shown in Table III. The diagnosis made before operation was thrombocytopenic purpura, which we were entitled to make from the available data. When the spleen was removed, it did not look typically that of a thrombocytopenic spleen, especially because of its size and because of the peculiar nodules which were present throughout the spleen. The anatomical diagnosis was Gaucher's disease inasmuch as typical foamy cells were found in both spleen and liver. When we looked at the conjunctiva there was no doubt that there was present a slight heaping-up of fat at the outer margin of the cornea, but the lesion was not very marked and I am quite sure that many normal individuals might show a similar slight heaping-up of fatty tissue.

In view of the bleeding tendency and the diminished platelet count indicating a condition of thrombocytopenic purpura, the indication for splenectomy is quite well marked, and justifiably so; this is borne out by the subsequent history, which up to the present is marked by total disappearance of the bleeding tendency. It seems unnecessary to emphasize, however, how little this will influence the underlying Gaucher's disease in which the thrombocytopenic purpura is an incidental symptom in a much more important systemic disease.

Group 3. Cases in Which the Indication for Splenectomy Is a Doubtful One and the Outcome Unpredictable and the Operation Is Commonly Done in the Absence or the Unavailability of Any More Conservative (Medical) Form of Therapy.—

CASE 4.—The fourth patient was a young boy, 7 years of age, who came to the hospital during a febrile episode with a history that he had appeared ill and lethargic for the prior four days. A "sore" throat was present on the day before admission. He had vomited several times in the past four days, the last vomitus containing blood. There was indefinite abdominal pain, no cough, no hemoptysis, no loss of weight, and no history of having swallowed any chemical or foreign body. Although the patient appeared acutely ill, the general physical examination was essentially negative. There was no rash, no ecchymosis, no petechiae, no evidence of bleeding from the gums. Nevertheless, during the examination he vomited about 200 c.c. of partially clotted, dark blood. There was a slight diastolic blow at the apex. The abdomen was relaxed, although there was some definite muscle defense spasm. The spleen was easily palpable three fingerbreadths below the costal margin. The liver was not palpable. Except for a few inconsequential nodules in the axilla the rest of the lymphatic system was negative. The patient's temperature persisted for about two weeks after which time it came down to normal. The condition of the liver and spleen persisted up to the time of operation. In view of the hematologic work-up (Table IV) a diagnosis of either Banti's disease or thrombocytopenic purpura was made and it seemed indicated to do a splenectomy.

A splenectomy was done thirty-one days after the onset of the symptoms. A small amount of clear fluid was found in the abdomen. The liver looked normal. The spleen was enlarged down to the umbilicus, and there were several small masses of accessory splenic tissue. The spleen and all the accessory splenic tissue were removed in one mass, and a biopsy of the liver was taken.

During the second week after operation there was quite a temperature reaction, but shortly this disappeared and thereafter the patient made an uneventful recovery and was discharged from the hospital well. The pathologic study was made by Dr. J. Felsen, who reported: "Sections of the spleen show a fairly good preservation of normal architectural arrangement. The periarterial lymph nodules are intact. The sinusoids are dilated and in one slide there is a central area of hemorrhagic infarction. Biopsy of the liver reveals linear and focal accumulations of round cells which are rather striking in that they occur chiefly at the periphery of the liver lobules. There is some cloudy swelling of the parenchyma. The picture suggests possible leucemia."

Comment.—The fourth case is presented because of the indefiniteness of the manifestations and impossibility of definitely classifying the essential lesion. It may be that the term Banti's disease is appropriate from the standpoint that the modern conception of Banti's disease is that of a terminal entity which results from a number of related or essentially differing preceding conditions. In the absence of any sharply demarcating signs, symptoms, or laboratory facts, the indication for splenectomy is an empiric one and is not as well founded as under other more well-defined circumstances. The outcome in such cases after a successful splenectomy cannot be foretold and must be awaited in hopeful expectancy. Since operation this patient has done reasonably well and has had no complaints, but continued observation over a long time is necessary before any definite opinion can be vouchsafed.

SUMMARY AND CONCLUSIONS

In the present state of clinical knowledge the indication for splenectomy in the clinical association of splenectomy and hypochromic anemia exists only under two conditions: (1) when in a person the subject of a hemolytic icterus spherocytes are demonstrable in the circulating blood; and (2) when in purpuric conditions the number of platelets in the peripheral blood is at a very low level. Under such conditions the operation is best done during a remission period, and when so done a good result is to be expected.

AN INSTRUMENT FOR VISUALIZING THE INTERIOR OF THE COMMON DUCT AT OPERATION

PRELIMINARY NOTE

MONROE A. MCIVER, M.D., COOPERSTOWN, N. Y.

(From the Surgical Service of the Mary Imogene Bassett Hospital)

THE problem of locating and removing all the stones in the common duct at the time of operation may be a difficult one. This is particularly true if multiple stones are present near the ampulla. Detection of the stone usually rests on the well-known maneuvers of probing the duct, or palpation, or a combination of the two. If these procedures are felt to be inadequate, the duct may be injected with some radiopaque medium at the time of operation and x-ray films taken to visualize the presence of a stone or other obstruction. This latter method at best may be cumbersome and time consuming, and occasionally presents difficulties in interpretation of the roentgenograms.

With a view to obtaining a more satisfactory method of approaching this problem, an instrument has been designed which may be inserted into the common duct at the time of operation, enabling one to inspect the interior of the duct. The instrument (the general form of which is shown in Fig. 1) consists essentially of a right angle observation telescope, a lighting and an irrigating system.* Preliminary observations were made on the cadaver to determine the optimum size for the instrument and its possibilities for visualizing foreign bodies in the duct. Fig. 2 was taken through the instrument and shows a stone lying in the common duct (the stone inserted into the lower end of duct of a cadaver).

The dimensions of the present model of the instrument are as follows: The upright portion is 1 cm. in diameter and 45 cm. in length, which allows observation from a distance sufficient to avoid the danger of soiling the operative field. The connections for battery and water are placed somewhat more than 9 cm. from the eyepiece, in order to avoid contaminating the hands during the use of the instrument. The right angle portion, which is inserted into the duct, is about 7 cm. in length and 5 mm. in diameter.

The instrument is used as follows. At operation, after careful palpation, the common duct is opened between two traction sutures in the usual manner. After testing the lighting and irrigating systems, the tip of the instrument bearing the light is passed downward in the duct. While the tip is being introduced, the index finger may be placed over the heel of the instrument (the junction of the upright and horizontal portions) in order to facilitate the insertion of the instrument and also

*The optical system was devised by Mr. Frederick C. Wappler, of the American Cystoscope Makers, Inc., New York City.

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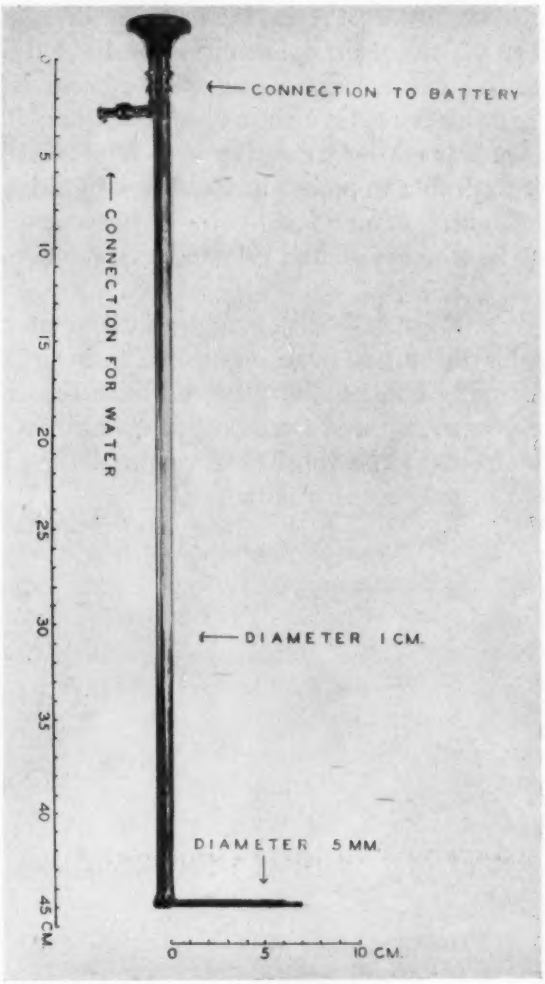

Fig. 1.—The choledochoscope.

Fig. 2.—Photograph taken through the choledochoscope, showing stone lying in the lower end of the common duct (stone inserted into the common duct of a cadaver).

to protect the liver. After the instrument has been introduced, it is desirable to turn off the main operating room light during the period of observation, but further darkening of the room is not necessary. It is essential, in order to obtain a clear vision, that the bile be thoroughly washed out by means of the irrigating system attached to the instrument, and it is desirable to maintain the flow of fluid while inspection is being carried out. After viewing the lower end of the duct, the instrument may be withdrawn and reintroduced for visualization of the upper portion of the duct.

Where the duct is greatly distorted by inflammatory processes, it might perhaps be difficult or even impossible to insert the instrument, but I have personally had no difficulty and have found that no larger opening in the duct is required than that customarily made for passing the usual instruments. The total time required for observation in a simple case need be only a few minutes.

Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

PROGRESS IN SURGERY OF THE AUTONOMIC NERVOUS SYSTEM IN 1938 AND 1939

JAMES C. WHITE, M.D., BOSTON, MASS.

(From the Neurosurgical Service of the Massachusetts General Hospital)

IT IS of particular importance for the clinical investigator and the neurosurgeon engaged in problems of vascular, secretory, and visceral innervation to have a broad understanding of recent developments in neuroanatomy and neurophysiology. Such basic knowledge is essential for the development of successful therapeutic procedures in visceral disease. An understanding of the anatomical arrangement of the autonomic system in the brain stem and spinal cord and of the physiologic effects of irritant and destructive lesions in these areas is also of considerable value in neurological diagnosis and in the avoidance of serious complications which may follow neurosurgical operations. It is for these reasons that so many contributions from the physiologic laboratories are included below.

ANATOMY AND PHYSIOLOGY

Cerebral and Hypothalamic Centers.—Our understanding of the function of the higher centers in the control of the autonomic nervous system has been greatly extended in the last two years. This work has been summarized by Fulton.[1] He points out that autonomic activities are integrated by the central nervous system according to the principle of functional levels. At the spinal stratum only simple vasomotor and sexual reactions can be demonstrated. At the medullary level reflexes are mediated for the maintenance of a constant blood pressure and oxygen supply. Other complex combined reactions of the autonomic and somatic spheres are also located at this level, such as deglutition and vomiting. Integration in the hypothalamus becomes very complex, as this is the principal control center of the autonomic system (see below). The cortex has a rich and varied representation of autonomic activities for the harmonious integration of somatic and visceral functions. According to Crouch and Thompson,[2] the cortex affects the visceral mechanisms as a whole rather than affecting the parasympathetic or sympathetic system from isolated areas. The active areas are largely limited to the motor and premotor regions. The effect of stimulating

these areas depends largely on the physiologic state of the organism and the cortex at the time of stimulation. The difference in species also seems to play an important role, the type of reaction being predominantly parasympathetic in the dog and sympathetic in the cat. Pinkston and Rioch[3] have shown that central mechanisms for vasomotor control are localized in the motor and premotor areas (Brodmann's Areas 4 and 6). Bard,[4] who has studied the influence of the cortex on subcortical levels for a number of years, has given a valuable summary of this important work. His conclusions are based on a study of the behavior of animals surviving complete removal of the cortex. Decortication brings out the inhibitory action of the cortex on the lower centers and shows that, with the possible exception of the full display of pleasure, the expressions of such basic emotions as anger, fear, and sexual excitement are effected by mechanisms which are suprabulbar and subcortical. Although these experiments were conducted on animals which stand in the middle third of the mammalian philogenetic scale, Bard believes that these centers still govern emotional reactions in man, even after the extensive corticalization of function which has taken place in the long period of evolution.

The demonstration that the most important vegetative centers are situated in the diencephalon, grouped around the walls of the third ventricle, the anterior commissure, and the tuber cinereum, began with the experiments of Karplus and Kreidl thirty years ago. It has culminated in the work of Ranson and his school in Chicago. These investigations have been summarized by Ranson and Magoun[5] and the entire subject discussed at a symposium by the Association for Research in Nervous and Mental Disease during a two-day meeting last December. In the proceedings of the Association[6] an effort has been made to correct the wide discrepancies in terminology by following a précis of anatomical terms. This closely follows Clark's nomenclature in the English monograph on the hypothalamus.[7] Evidence obtained from stimulation of discrete areas in the hypothalamus by Ranson and Magoun[5] indicates clearly that the sympathetic discharge originates in the paraventricular areas; there is less conclusive evidence that the more rostrally situated preoptic and supraoptic nuclei are concerned with the parasympathetic division. The latter area in addition gives off a well-defined tract to the posterior lobe of the hypophysis and is of great importance in the control of the antidiuretic hormone and thereby of renal secretion.

The elusive problem of the location of the descending autonomic fiber tracts has been partly cleared up by Magoun.[6] This work, performed in Ranson's laboratory, was carried out by placing lesions along the brain stem with the Horsley-Clark stereotaxic instrument and then observing whether the characteristic pressor responses normally obtained on hypothalamic stimulation were abolished. Evidence was obtained

that the autonomic pathway descends in both the central and tegmental portions of the midbrain. In the pons these fibers are more concentrated in the tegmental region and in the medulla they lie chiefly in the lateral portion of the reticular formation. This coincides with clinical observations recorded by List and Peet,[8] who studied abnormalities in sweating in patients with lesions of the brain stem, and also with evidence secured by Foerster, Gagel, and Mahoney[9] from studies of tumors in this region. From the medulla the pathway enters the anterolateral column in the upper cervical cord. This also has been corroborated in man by Foerster, who observed an ipsilateral Horner's syndrome and diminished sweat secretion after high cervical section of the spinothalamic tract. Foerster also ascribes the fall in blood pressure and loss of vasoconstrictor reflexes after bilateral high cordotomy to interruption of this tract. According to Harrison, Wang, and Berry,[10] hypothalamic impulses may descend to the spinal cord uncrossed or may cross in the brain stem or in the spinal cord below the cervical segments.

Ranson's[6] method of selective destruction of the anterior or the lateral hypothalamic nuclei has shown the role of these centers in the regulation of body temperature. When this area of the brain is heated, heat elimination is increased by an acceleration in the rate of respiration, panting, and sweating of the footpads.[11] These results are interpreted as indicating that this region contains centers which are activated by rising temperature of the blood and that their stimulation leads to elimination of excess heat. Of particular importance to neurosurgeons are the observation in animals that hyperthermia of central origin is reduced by the barbiturates and the suggestion that large doses of these drugs be given when a dangerously high fever follows operative intervention in these areas. Some remarkable instances of loss of temperature regulation associated with small circumscribed tumors in the hypothalamic area have been described by Davison[6] and Zimmerman.[6] Of further clinical interest is the microscopic study of the hypothalamic nuclei in individuals who have died of heatstroke. Morgan and Vonderahe[12] have observed significant evidence of cellular destruction in the exact areas which regulate temperature control.

The effects of hypothalamic stimulation on gastrointestinal activity are reported by Sheehan.[6] Stimulation of the lateral nuclei is followed by inhibition of peristalsis and decrease of muscle tone, with reduced secretion of gastric juice and an increase in mucous content. There is also some evidence that stimulation of the supra- and preoptic areas produces motor responses and an increased acidity of the gastric juice, but this has not been a consistent finding. Sheehan also points out that extensive destruction of the diencephalon is followed by mucosal hemorrhage and erosion in about one-third of all experiments, and that these complications occur much more frequently than after injury to any

other part of the brain. Attention was often directed by Cushing to gastrointestinal complications in man after operations on the pituitary and third ventricle.

Evidence secured from lower animals cannot always be safely transferred to man, so White[6] was led to repeat the observations on stimulation of the hypothalamic areas in man. This can be done effectively and safely under local anesthesia during drainage operations on the third ventricle for internal hydrocephalus. The cardiovascular responses in five patients were quite similar to those obtained in animals.

Chemical Mediation of Nerve Impulses.—Evidence which has been summarized in preceding reviews of this series[13e-h] has brought out with increasing weight the importance of chemical mediation in the distribution of nerve impulses. The argument over electrical versus chemical propagation of the nerve impulse to visceral and skeletal muscle, as well as across interneuronal synapses, has been intense. Recently Cannon[14] has presented evidence which seems to prove conclusively that this process is entirely chemical. A corollary to this phenomenon, which is of great practical importance in the technique of surgical procedures, is the sensitization to adrenaline, sympathin, and acetylcholine which follows nerve degeneration. After summarizing this evidence, Cannon[15] has formulated a Law of Denervation to the effect that, when a series of efferent units is destroyed, increased irritability to chemical agents develops in the isolated structure, the effect being maximal in the part directly denervated. Through sensitization the dose of the chemical substance required to produce a response is less after operation than before. Whereas extreme sensitization results from cutting the ultimate adrenergic fibers (postganglionic section), a moderate sensitization develops after preganglionic section. The practical importance of this phenomenon is illustrated in vascular denervation of the extremities. Striking and long-lasting vasodilatation follows lumbar ganglionectomy in which only preganglionic fibers to the sciatic nerve are cut, but after postganglionic section, such as occurs in injuries to peripheral nerves or in cervicothoracic ganglionectomy, the initial complete relaxation of the vessels is soon followed by the return of a certain degree of vasoconstrictor tone. After injuries to the peripheral nerves this is so pronounced that it accounts in large part for the vasomotor and nutritional changes which may be such a distressing complication (Atlas[16]).

The sensitization effect necessitates a very thorough denervation of a given area, so that the secretion of sympathin at the nerve endings of remaining intact postganglionic axones or of acetylcholine liberated in the ganglionic synapses and adrenal medulla after an incomplete preganglionic sympathectomy will not spread to the denervated but sensitized cells and reproduce the response. Simeone[17, 18] has shown that a partially denervated adrenal gland or sympathetic ganglion (after de-

generation of a large part of its preganglionic axones) reacts with increased activity when the remaining efferent connections are stimulated.

An ingenious illustration of the increased sensitivity of visceral and skeletal muscle has been given by Bender.[19] Since the sympathetically denervated pupil dilates with adrenaline and the denervated striated muscles of the face contract with acetylcholine, they may be used as indicators for exogenous and endogenous adrenaline and acetylcholine. In the cat, which reacts to fear with a predominant secretion of adrenaline, the denervated pupil dilates widely, whereas the denervated facial muscle gives but a minimum response. In the frightened monkey the denervated pupil does not dilate unless it is rendered additionally sensitive by cocaine, but the denervated facial muscles contract vigorously. These observations indicate that both parts of the autonomic nervous system are active in each species. The cat, however, is predominantly sympathetic, while the monkey is predominantly parasympathetic in its reactions.

Further implications of the sensitization phenomenon are seen in the peculiar complications which sometimes follow injury to the cranial nerves. Lewy, Groff, and Grant[20] have investigated the pseudomotor responses which occur after injury to the oculomotor, facial, or hypoglossal nerves. The ensuing pseudomotor reactions which occur in the eyelid, whiskers, or tongue can be reproduced by stimulating the mesencephalic root of the trigeminal nerve. An autonomic discharge spreads over the nerve, resulting in a slow tonic contraction of the denervated muscles of the eyelid, face, and tongue identical with the effect of acetylcholine injection into the carotid artery of animals so denervated. This probably explains the Marcus-Gunn phenomenon, in which the eyelid is raised when the patient chews, and the Heidenhain and Vulpian phenomena, in which the lip and tongue, respectively, contract when the second trigeminal division in the first case and the chorda tympani or lingual nerves in the second case are stimulated. Another peculiar autonomic disturbance, the phenomenon of "crocodile tears," which may occur on eating after injuries to the facial nerve, is ascribed to aberrant regenerating fibers, so that some of the autonomic fibers which once entered the chorda tympani nerve in their course to the salivary glands become misdirected and reach the lachrymal gland (Russin[21]).

The importance of the autonomic nervous system in the mechanism of accommodation has recently been described by Cogan.[22] His paper, which covers a field to which scant attention has been paid and which contains a valuable bibliography, should be of great interest to the surgeon as well as to the ophthalmologist, because a number of patients complain of mild visual disturbances after cervical and upper dorsal sympathectomy. Cogan concludes that stimulation of the sympathetic fibers flattens the lens and accommodates the eye to distant objects,

whereas the parasympathetic aids in focusing on objects at close range. The effect of sympathectomy is not sufficient to make the subject obviously myopic, but the condition is usually detectable by optometric tests.

In addition to the articles on the special subjects which have been covered above, there is a vast number of papers of anatomic and physiologic interest. The reader who is concerned with these fields should read the recent review by Hinsey.[23]

EFFECTS OF SYMPATHECTOMY ON CIRCULATION

The Carotid Sinus.—A useful anatomic description of the carotid sinus innervation, accompanied by excellent photographs, has been written by Tchibukmacher.[24] The clinical importance of a hyperactive carotid sinus reflex in producing syncope from bradycardia and peripheral vasodilatation, as well as its etiological role in convulsive seizures, has been so well described in the past that nothing new of importance has been reported. Capps and de Takats,[25] however, have reported two cases in which bilateral denervation of the sinus has been performed. Both of these show a significant postural hypotension, but no elevation of the blood pressure or heart rate as a result of removing these important reflex mechanisms for cardiovascular control. Rovenstine and Cullen[26] have described the anesthetic risks in operating upon patients with an abnormal sinus reflex. They state that digitalis and most of the volatile anesthetics in light dosage sensitize the reflex mechanism. To avoid anesthetic accidents, they recommend routine testing by local compression of the carotid bifurcation before operation. Atropine eliminates the vagal cardiodepressor type of reflex. If an abnormal reflex is produced during operation, it may be recognized by the accompanying circulatory changes. The most urgent and important emergency treatment consists of the injection of procaine at the carotid bifurcation.

Vasospastic Diseases.—A monograph on the control of the blood vessels has been written by McDowall.[27] This contains information on all aspects of vascular physiology and is an invaluable textbook for reference. In the same field Kunkel, Stead, and Weiss,[28] and Grant and Pearson[29] have extended our understanding of vasomotor reactions in the limbs by comparing vascular responses in the proximal and distal portions of the extremity. Both sympathetic stimuli and adrenaline, as is well known, induce vasoconstriction in the fingers and skin, but in the muscles of the forearm and leg the reverse is true.

The perennial arguments concerning the etiology and treatment of Raynaud's disease are still not completely settled. With the exception of the Mayo Clinic, most investigators are agreed that preganglionic sympathectomy is distinctly more effective than postganglionic denervation. A reason for this is the lesser degree of sensitization to sym-

pathomimetic substances which results (see above). Lewis[30] states that he is "prepared to accept clinical evidence for this conclusion. The preganglionic operation has the merit not only of producing, so it would seem, the greater vasodilatation, but in avoiding the disfigurement of Horner's syndrome." Lewis adds that, even after this improved operation, he can still induce attacks of Raynaud's disease on direct exposure to cold and that the local abnormality remains. In another article Lewis[31] compares the pathologic changes in the arteries of warm-handed people with those in patients with Raynaud's disease. Intimal thickening becomes distinct in both groups with advancing age and is no greater in the mild cases of Raynaud's disease than in the normal controls. This fits in with Lewis' theory of local increased sensitivity to cold. In the more advanced cases with trophic changes in the skin there is intimal hyperplasia, the arterial lumen being greatly reduced or actually occluded by proliferative tissue and organized thrombus. Opposed to Lewis' theory of an entirely local vascular fault are the findings of Day and Klingman.[32] They studied vasomotor reactions in a 6½-year-old girl with acrocyanosis and found that during sleep there was spontaneous warming and reddening of the hands and feet. Local cooling of the hand during sleep did not cause vasospasm. They believe that their study supports the theory of a central rather than a local origin of this abnormal vasomotor tone.

If the dispute over the etiology of Raynaud's disease is still far from settled, the same is true concerning the best method for preganglionic denervation of the upper extremity. Most surgeons agree that cervicothoracic (stellate) ganglionectomy no longer should be done for vascular disturbances, because the denervated smooth muscle of the arterioles becomes so sensitive to sympathomimetic compounds. Telford[33] and Smithwick[34] each have described a technique for preganglionic denervation of the arm in which the inferior cervical, first and second thoracic ganglia which give rise to the post-ganglionic neurones are left undisturbed, but their central connections are cut. Smithwick's operation through a posterior approach with resection of the third rib would seem to give a better chance to prevent regeneration of fibers from the second and third intercostal nerves. The ability of the sympathetic vasomotor fibers to regenerate is amazing. Simmons and Sheehan[35] tested Telford's series of 38 ganglionectomies and 29 preganglionic sections. They found evidence of relapse in all but 24 per cent of the preganglionic denervations and in all but 10 per cent of the ganglionectomies. In this checkup Simmons and Sheehan state that they took the slightest attack of cyanosis to mean relapse, although the patient may not have attached any importance to it. They also add that the majority of patients after the preganglionic operation were completely satisfied with the result. Therefore they favor the preganglionic operation, saying of it that "clinically they [the patients] are undoubtedly better, the hands never

relapsing to the severe degree which we have seen occur in some of the ganglionectomies. The absence of the Horner syndrome is also a distinct advantage, though many of the ganglionectomies have lost this syndrome after a few years, again suggesting regeneration of nerve fibers.''

In addition to the possibility of late relapse from regeneration, there are other less valid objections to the present methods of preganglionic denervation of the upper extremity. Kuntz, Alexander, and Furcolo,[36] as well as Heinbecker and Bishop,[37] claim that there are both vasomotor and sudomotor fibers in the first thoracic root, so that vasoconstrictor impulses can still reach the brachial plexus unless the white communicating ramus of this nerve is severed. All these observations were made on cats, and one must remember that there are wide anatomical species differences. Hinsey[23] has been unable to find evidence of such fibers in the first thoracic root of animals, and there is certainly nothing to suggest their presence in the large series of postoperative cases that has been examined for this very point at the Massachusetts General Hospital. Objection has been raised by Fatherree and Allen[38] to the physiologic concept that sympathectomized blood vessels become abnormally sensitized to adrenaline and with greater intensity after postganglionic than after preganglionic denervation (Cannon's Law of Denervation). In their experiments these investigators used such large doses of adrenaline that they missed the selective effect which is produced by this hormone on all denervated smooth muscle and with greatest intensity after degeneration of the postganglionic fibers.

A new method of dealing with thrombophlebitis has been advocated and received much favorable support during the past two years. In 1934 Leriche and Kunlin[39] suggested immediate infiltration of the lumbar ganglia with procaine in patients with acute thrombophlebitis, and in a second article Leriche[40] has recommended the resection of these structures in patients with painful swelling, coldness, and ulceration of the legs in the chronic stages. The rationale of the procedure, according to Leriche, depends on the relief of reflex vasospasm, which in turn is responsible for many of the manifestations. DeBakey, who worked with Leriche, brought the method to this country and with Ochsner[41] has written a number of enthusiastic reports about it. They believe that the edema is due to anoxia from reduced circulation and the resultant increase in capillary permeability, and that a series of procaine injections is usually sufficient to interrupt the vasoconstrictor reflex from the thrombosed veins and thereby to increase local circulation, relieve pain, and promote resorption of edema fluid. By preventing the persistence of edema, subsequent fibrosis and the development of chronic lymphedema may be prevented.

Hyperhidrosis.—A most interesting and valuable study on sweat secretion in man has been published by List and Peet. They classify sweating as of thermoregulatory, emotional, gustatory (produced by

eating spicy food and confined to the face), spinal reflex, and drug origins.[42] Innervation of the sweat glands is described and the regional loss of thermoregulatory sweating illustrated after various surgical and pathologic lesions of the sympathetic pathways.[43] Two other articles deal with sweat secretion after various drugs[44] and the peculiar disturbances which may occur in the face.[45] An article by White[46] describes the nervous variety of sweating in the hands and feet which is closely related to Raynaud's disease and the satisfactory results after sympathectomy.

Hypertension.—The literature on hypertension during the century which has followed the observations of Bright has been reviewed in a provocative manner by Scott.[47] He concludes that all the evidence for the etiology of this condition points to the view that essential hypertension, in the light of Goldblatt's experimental work, is of renal origin. The knowledge that this form of hypertension is of chemical origin and not due to excessive vasoconstriction at first glance does not seem favorable to any neurosurgical form of intervention. Undoubtedly surgical treatment is still in the experimental stage, but opinion is beginning to crystallize that extensive interruption of vasoconstrictor impulses to the splanchnic bed and lower extremities is of value in suitably selected cases. Over three-quarters of the patients show a striking symptomatic improvement, regardless of whether the blood pressure falls or not, and the operation carries extremely little risk. Sympathectomy should be performed on more patients in the early stages of hypertension; it is useless in the severer grades, as well as in the majority of patients over 50 years of age. It is quite obvious that, even if patients are selected with the utmost care, the results are not consistently good and that the fall in the diastolic pressure is not as great as in the systolic. The results of resection of the splanchnic nerves and a limited number of sympathetic ganglia in carefully selected cases with adequate postoperative observation have been summarized in Table I.

TABLE I

AUTHOR	NO. CASES	SIGNIFICANT REDUCTION	MORTALITY	FOLLOW-UP PERIOD
Craig and Adson[48]	237	52%	0	2 mo.+
Moore[49]	22	45%	4.0%	30 mo.+
Smithwick[34]	34	59%	0	1-20 mo.
Braden and Kahn[50]	173	49%	3.4%	*

*Of 33 cases followed from 2 to 5 years, 30 maintained a satisfactory reduction of blood pressure.

The question has been raised by Volini and Flaxman[51] whether denervation really produces any specific effect on blood pressure. They claim that the degree of symptomatic relief and reduction in blood pressure in the presence of essential hypertension is sometimes greater after nonspecific surgical procedures (hysterectomy, prostatectomy, chole-

cystectomy) than that obtained by extensive sympathectomy. But Page[52] has given valid evidence that the favorable results of sympathectomy are truly specific, pointing out that when the operation is performed in two stages there is only a brief fall in blood pressure after the first stage, but a sudden, far more striking and lasting effect which comes on dramatically as the nerve structures are cut during the second stage. Davis and Barker[53] have found that, in addition to its specific effect on blood pressure, splanchnicectomy may increase the value of potassium sulphocyanate medication.

VISCEROMOTOR AND VISCEROSENSORY FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM

Paroxysmal Tachycardia.—The observation that long-lasting attacks of paroxysmal auricular tachycardia, which cannot be stopped by medical measures and are so severe that cardiac failure threatens, may be stopped by chemical or surgical interruption of the cardiac accelerator nerves is not new, but is not as generally known as the importance of the condition warrants. Coleman and Bennett[54] have reviewed the literature and presented an interesting case report of a patient who had multiple daily bouts of tachycardia coupled with a diseased gall-bladder. In view of two previous fatalities from intractable tachycardia and decompensation in similar cases, they were afraid to remove the gall bladder. By means of an injection of alcohol into the right stellate ganglion (the right seems more important than the left in reducing the irritability of the pacemaking mechanism) the attacks of paroxysmal tachycardia were stopped and cholecystectomy was performed without disturbance of cardiac rhythm four and one-half months thereafter. This was the first period in twenty years during which the patient had been free from her attacks.

A somewhat similar experience has been described by Leibovici, Dinkin, and Wester[55] in which a young man following appendectomy developed a severe form of paroxysmal tachycardia. This proved resistant to medical measures, but ceased abruptly when the stellate ganglion was injected with procaine and did not recur.

Angina Pectoris.—Miller[56] has published a small monograph with numerous line drawings which illustrate in a most useful manner the anatomical arrangement of the nerves to the heart. Moore,[57] who has so thoroughly investigated the mechanism of visceral pain, points out that, whereas the somatic system innervates the surface of the body and provides a defense against external violence, the viscera are relatively insensitive to mechanical trauma but develop pain with certain changes in the internal environment. As far as the heart is concerned, the painful stimuli are ischemia and its products (lactic acid).

Three years ago Bérard, one of Leriche's assistants, studied the results of paravertebral alcohol injection in the treatment of angina pectoris in

this country and compared the results with those obtained by other procedures. Of the many different methods which he describes in his thesis,[58] preference is given to stellate ganglionectomy, as performed by Leriche in Strasbourg, and to paravertebral blocking of the upper thoracic ganglia with alcohol. A rather similar study has been reported by Jessen-Aarhus[59] and preference given to the injection method. Flothow,[60] one of the proponents of paravertebral injection, has submitted a number of younger patients without evidence of advanced coronary disease to resection of the inferior cervical and upper thoracic sympathetic ganglia through an anterior incision. This method is also being used at the Massachusetts General Hospital. It gives a higher percentage of relief than removal of the stellate (cervicothoracic) ganglion alone or alcohol injection and also avoids the not too infrequent complication of alcoholic neuritis. In addition, the anterior approach permits the operation to be carried out with the patient lying on his back. Operations in the presence of coronary disease are less safely performed with the patient in the prone position, where interference with respiration and venous return may be dangerous factors.

Raney[61] has advocated a new operation which involves excision of the posterior portion of the third, fourth, and fifth ribs in the prone position. He recommends dividing the lower end of the sympathetic chain and cutting the rami of its second to fifth ganglia, without resection of the ganglia themselves. Although good results are recorded in eleven cases, many theoretical points are open to criticism. From the anatomic angle it is probable that important connections will be missed, at least in some patients, if the fibers through the first thoracic ganglion are not interrupted. It is claimed that the operation is primarily on the efferent fibers to the heart and that it is preganglionic. Whether the first point, that the sensory mechanism is left largely intact, is true or not, the second is incorrect, since the thoracic cardiac nerves contain postganglionic fibers (Nonidez[62]). Raney himself admits that according to the best available evidence the sympathetic fibers are coronary dilator, but he feels that somehow in coronary disease the mechanism may be reversed. Surgeons who have had a wide experience with operations on the upper thoracic sympathetic structures must realize their extraordinary tendency to regenerate unless wide areas are excised.

Congenital Megacolon.—The safety and other advantages of procedures aimed at sympathetic denervation of the colon in children with Hirschsprung's disease have become so generally recognized that the older methods of colonic resection are falling into disrepute. Mortality in the latter group is formidably high and, as de Takats and Biggs[63] point out, a progressive dilatation of the segment proximal to the resection has been reported too often to be ignored. The diagnostic and therapeutic value of spinal anesthesia has been re-emphasized by Telford

and Simmons.[64] There is also evidence that acetylcholine is of value as a diagnostic test, due to its stimulant action on the parasympathetic outflow (de Takats[65]).

As regards indications for denervation in patients with megacolon, Telford[66] believes that operation should be performed in children who are not relieved by conservative medical treatment by the age of 5 or 6 years. He thinks that bilateral resection of the lumbar chains is the operation of choice. Resection of the inferior mesenteric and superior hypogastric plexuses may be followed by regeneration, and division of the splanchnic fibers is of value only when the ascending colon is involved.

A monograph devoted to the subject of megacolon has been written by Pässler[67] from the University Clinic in Leipzig. This book is a valuable contribution because of its wide review of the literature, theories of etiology, and review of surgical treatment. Pässler points out that there is little to recommend in the older types of operation on the colon and describes the three standard types of neurosurgical intervention. These consist in bilateral removal of the lumbar chains, resection of the inferior mesenteric and superior hypogastric plexuses, and subphrenic splanchnicectomy combined with upper lumbar ganglionectomy. Each of these three procedures has given good results, but the second is preferable when the bladder is enlarged as well as the colon. Pässler describes the different varieties of the condition, its medical and surgical treatment, and the frequent association of enlargement of the bladder with the idiopathic congenital form of the disease. Experiences in 10 cases are reported in detail and the results of sympathectomy in 117 patients summarized from the literature. Of these, 38 were fully relieved, 64 were improved, 12 were not relieved, and 3 died.

Bladder Pain and Retention.—The problem of how large a role is played by the sympathetic division in bladder pain and disorders of micturition still remains a subject of dispute. According to the best experimental evidence, bladder sensation and motor power are mediated by the parasympathetic fibers in the second, third, and fourth sacral nerves, although some contractile innervation may reach the region of the trigone and internal sphincter via the sympathetic fibers in the superior hypogastric plexus. This work has been reviewed in McLellan's monograph on *The Neurogenic Bladder*.[68] A comparison of cystometrograms made before and after presacral neurectomy shows that neither the response of the normal bladder musculature to stretch nor its sensation is in any way altered by presacral neurectomy (Munro[69]). Nevertheless, numerous case reports continue to emanate from well-known clinics recording relief from both bladder retention and pain by this operation. According to Nesbit and McLellan,[70] it is possible that sympathectomy may relieve certain forms of bladder pain, not by interrupt-

ing afferent pathways, but by reducing spasm of the internal sphincter. They report an interesting series of patients suffering from dysuria secondary to various forms of chronic cystitis with the predominating feature of vesical spasm, where resection of the superior hypogastric plexus was followed by uniformly good results. In a very similar series of eleven cases Scott and Schroeder[71] have observed striking relief in all but one patient. They believe that better results can be obtained if the upper sacral sympathetic ganglia are resected along with the superior hypogastric plexus, which is contrary to the opinion of Nesbit and McLellan. In patients in whom operation has given insufficient relief, Scott and Schroeder have supplemented the resection by subarachnoid alcohol injection. White[72] has devised a modification of intrathecal alcohol injection which blocks the lower sacral sensory roots bilaterally and has found that this is sufficient to relieve the pain of malignant disease in the bladder neck. This is a most useful method to relieve severe pain in the lower rectum, urethra, perineum, and external genitals, but it entails a considerable risk of bladder paralysis and can therefore be used with safety only in patients who are already on constant drainage. Corollary to this, Simmons[73] has pointed out that the retention of urine, which frequently follows perineal resection of the rectum, is brought about by injury to the parasympathetic fibers which run in the anterior divisions of the lower sacral nerves (nervi erigentes). He claims that resection of the superior hypogastric plexus at the time of the preliminary laparotomy and colostomy has been followed by a considerable diminution in the incidence of postoperative retention of urine. This latter point is still open to discussion (Munro[69]).

Uterine Pain.—Whereas bladder sensation is in large part, if not altogether, carried in the sacral parasympathetic rami, there is no longer any question that the pain of idiopathic dysmenorrhea is relieved by presacral neurectomy. The cases must be carefully selected to exclude pain from the ovaries and other related structures and the dissection of the presacral plexus must be meticulous and complete. A good anatomical description of this plexus has been given by Labate,[74] based on dissection of seventy-five cadavers, which should be of considerable help to the surgeon who wishes to familiarize himself with this operation.

A most instructive report on the value of presacral neurectomy in essential dysmenorrhea has been given by Meigs.[75] He is the one surgeon who has published statistics in a series of patients where the superior hypogastric plexus was resected without any other pelvic surgery being done to becloud the issue. Of his 20 patients, 15 had a successful result. There were partial successes in 2 other cases and in 3 there were complete failures. Meigs concludes that this operation, with the necessary correction of obvious pelvic abnormalities, is the best form of treatment for patients with true primary dysmenorrhea.

Phantom Limb Pain and Minor Causalgias.—One of the most puzzling aspects of an already difficult problem is the relation of the sympathetic nervous system to pain in the extremities. The work of Moore[57] has demonstrated conclusively that pain from the arteries of the extremities is transmitted over the mixed peripheral nerves and not over autonomic pathways. The situation in the periphery is quite different from visceral artery pain, where sensory axones which traverse the sympathetic trunks play a most important part. Notwithstanding this apparent elimination of the sympathetic system from the role of sensory innervation of the limbs, a number of convincing reports have appeared in recent years which give evidence that certain types of pain can be relieved by chemical or surgical interruption of the sympathetic fibers. Whether this effect is secondary to an improvement in circulation or to some other obscure cause at present cannot be stated. Two most interesting papers on phantom limb and on post-traumatic pain syndromes by Livingston[76, 77] have recently appeared. In each of these it is brought out that interruption of the reflex arc, either at the trigger point or proximally in the afferent path or in the paravertebral outflow of the sympathetic rami, will often break the vicious circle and yield satisfactory relief. After repeated injections of procaine, and sometimes even after a single block, many of these patients, who are such a problem to the insurance company and the physician, have been cured without the need of a surgical operation.

The purpose of this review has been to summarize new work of fundamental value in understanding the complex integration of the autonomic nervous system in man and reports of clinical cases which emphasize the correctness or fallacy of its surgical application. No new operative procedures of importance have been developed in the past two years. A number of special monographs of considerable value have been published and are listed above.[6, 7, 27, 56, 58, 67, 68] In addition, Scupham, de Takats, and co-workers[78] have written a special article on vascular diseases which gives a very complete summary of this subject. Because of language difficulties it has been impossible to cover the literature beyond the American, English, French, and German sources. Few references from German periodicals have been included, because they have contained little of value.

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Editorial

Cooperative Research and Priority

IN SUCH strenuous times as now confront us, it is of the greatest importance that information valuable in the care of those in the armed services be made readily available. Investigators, as a group, are rightly slow in publishing their findings until they are sure, beyond a reasonable doubt, of the significance of the data they have obtained. On the other hand, some investigators imagine themselves impelled to hasten publication because they feel that if they wait until completion of their studies someone working in a similar field may establish priority. Publications in the latter category have resulted too frequently in the premature adoption of therapeutic procedures which additional evidence and thought proves to be worthless and at times even harmful.

Several years ago President Conant, in a report to the Trustees of the Harvard Corporation, stated that it was not at all unlikely that the greatest advances in science in the future would come from cooperative research. One might, without fear of contradiction, add to this statement that all significant contributions to medicine have been in a sense the result of nonintegrated cooperative research. Every investigator utilizes, to some degree, the work of others in the conduct of his individual research.

Within the coming months it will become necessary, with increasing frequency, to obtain authoritative information in the shortest possible time. This, in many instances, will require the pooling of our scientific resources. This will be especially true in medicine, where the application of observations made in our laboratories of fundamental science will be put to the test of final clinical verification. It is of the greatest importance that in this program priority play no part and that individual or departmental ambitions be submerged for the greater good.

The investigations already begun in numerous laboratories under the general direction of governmental agencies will demonstrate perhaps the fullest possible effect of cooperative effort. It will show perhaps that a broader fundamental knowledge of a specific subject can be obtained in a shorter period of time by cooperative effort. It may prove to be costly from the economic point of view, but cost in dollars will mean little if the information received will lead to a reduction in the morbidity and mortality of a host of conditions that may confront us.

In such a program of free cooperative effort individual priority, of course, must be submerged. This, I believe, will be of little importance, for after all, while priority in a truly fundamental problem may be of importance, it should be a matter of little consequence, especially at this time, in the daily routine of laboratory and clinical investigation.

—I. S. Ravdin, M.D.
Philadelphia, Pa.

Review of Recent Meetings

REVIEW OF THE MEETING OF THE AMERICAN ASSOCIATION OF OBSTETRICIANS, GYNECOLOGISTS, AND ABDOMINAL SURGEONS, SEPT. 26, 27, AND 28, 1940, EXCELSIOR SPRINGS, MO.

RICHARD PADDOCK, M.D., ST. LOUIS, MO.

(From the Department of Obstetrics and Gynecology, Washington Universiay School of Medicine)

THE fifty-third annual meeting of the American Association of Obstetricians, Gynecologists, and Abdominal Surgeons was held at The Elms, Excelsior Springs, Mo., Sept. 26, 27, and 28, 1940. The meeting was well attended by fellows of the society and their invited guests. The entire program of sixteen papers was presented.

Calvin R. Hannah, Dallas, Tex.: **Home Delivery Service by Students.**—An outline of the obstetrical curriculum at Baylor University was presented. Certain practical considerations of pregnancy for teaching were given; namely, the custom of referring to the fetus in all stages of pregnancy as "the baby" and the importance of recognizing the stages of labor, with attention to the effacement of and dilatation of the cervix. The course and progress of the senior students in home delivery work was outlined. The senior work includes training in the city and county hospitals where students follow the course of labor, do rectal examinations and scrub up for the delivery before the home delivery. Then there is a period of time as "second-call man" when home delivery is observed and assistant work is done preceding the actual delivery. Following this period, the senior does home deliveries and has full equipment. Hannah presented a review of results in a large series of home delivery cases.

George W. Kosmak, New York City, stated that institutional births are increasing in number. It is questionable if this is always ideal, since some institutions are not always so safe. He considers home delivery an essential factor in teaching obstetrics. **Grandison D. Royston**, St. Louis, discussed hospital facilities for teaching students and home delivery methods. He then demonstrated a portable delivery table and paper drapes, designed by Dr. E. F. Bruning and used on the outpatient service at Washington University. **Irving W. Potter**, Buffalo, N. Y., outlined his experience with home delivery. He stressed the importance of recognition of labor. **James L. Raycraft**, Cleveland, Ohio, considered outpatient work a matter for adequate and close supervision. This he stated, is important for good teaching and for good results. **Ward F. Seeley**, Detroit, urged supervision on home delivery service to avoid repetition of mistakes a student might make. He believes that a minimum amount of equipment is best for the student to use. Hannah, in closing, mentioned the ease with which chloroform

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may be used. The preparation on the home service is the same as in the hospital. One student prepares the patient and may do the work of a nurse. Complicated cases are brought into the hospital.

B. Z. Cashman and **John S. Frank,** Pittsburgh: **Deep Cauterization of the Cervix—A Factor in Reducing the Mortality of Hysterectomy.**—Since infection is an important factor in the mortality of hysterectomy and since there is infection in the cervix in the majority of patients requiring hysterectomy, the authors feel that special procedures are necessary to sterilize the cervix. The infection is frequently so deep-seated that usual cleansing of the vagina and cervix does not reach the infection. The deep cauterization has been the most successful method of sterilizing the cervix and prevents future trouble with the cervical stump. Deep cauterization of the cervix, combined with subtotal hysterectomy, makes total hysterectomy for benign conditions unnecessary. The authors reviewed a series of consecutive hysterectomies by this method for the past six years, presenting tables of results.

Walter T. Dannreuther, New York City, mentioned little difference in mortality of total hysterectomy and subtotal hysterectomy if done correctly. He favors the supravaginal hysterectomy with retention of the cervix, unless the condition of the cervix is pathologic enough to require removal. He mentioned various methods of treatment of the cervix before operation. **Virgil S. Counseller,** Rochester, Minn., stated that good results depend on working with a method to which one becomes accustomed. He favors total hysterectomy because of the associated reconstruction of the vaginal vault. The results are better after removal of the cervix, especially in multiparas. He quoted a mortality rate of less than 1 per cent in benign conditions with total hysterectomy. Frank presented some tables and figures that were not included in the paper as read. **Joe V. Meigs,** Boston, cited several cases of carcinoma of the cervix after subtotal hysterectomy. He mentioned his own observations of such cases and expressed his favor of the total hysterectomy. **A. J. Rongy,** New York City, stated that no single method of hysterectomy is good in all cases. He described how he favors the peritonealization of the cervical stump and draws it up to prevent vaginal shortening. **William H. Weir,** Cleveland, stated his preference for the complete hysterectomy. He also mentioned a number of cases illustrating his points. **A. D. Campbell,** Montreal, Canada, presented some points important in the reduction of mortality in hysterectomy. He believes it important to take blood sugar determinations before operation. The technique of operation should be determined by the limitations of the operator. Drainage should be established by an opening in the vaginal vault below the peritoneum. Total hysterectomy carries the lower mortality. **Channing Barrett,** Chicago, presented a number of points in the technique of hysterectomy. **James W. Kennedy,** Philadelphia, considered cauterization of the cervix important before hysterectomy. He uses soldering irons in his technique. He mentioned that possibly 95 per cent of all hysterectomies throughout the country are supravaginal. **Mortimer W. Hyams,** New York City, classified various degrees of cervical involvement with infection. Conditions of treatment differ with different degrees of cervical involvement. In deep involvement the effects of cauterization and conization differ. He doubts if deep areas are reached in fourth degree involvement. Cashman, in closing, pointed out that subsequent stricture is not a factor in deep cauterization if hysterectomy is done. No further treatment of the cervix is necessary if deep cauterization is well done.

Frederick H. Falls, Vincent E. Freda, and **Harold H. Cohen,** Chicago: **A Skin Reaction for the Diagnosis of Pregnancy.**—A difficulty in various tests for pregnancy is the obtaining of a suitable antigen. Most precipitation tests for pregnancy are inaccurate due to lack of a high enough percentage of correct results. In looking about for a suitable antigen breast tissue was used and then colostrum. The techniques of injection and control were described. Drawings were presented to show the various reactions. The results in 265 cases of known pregnancy were reported. A series of known controls, including men, children, and gynecologic patients, was reported. A group of problem cases was listed as to accuracy of results.

Lawrence M. Randall, Rochester, Minn., mentioned the common pregnancy tests available. In many of the tests an incidence of error may reach 20 to 25 per cent. This, he stated, is due to the fact that the substances that give a positive reaction are associated with pregnancy, but still may be present in other conditions. In any skin test the correct interpretation of the reaction depends on the wheal formation and one's familiarity with it. **A. J. Rongy,** New York City, gave examples of misleading reactions in pregnancy tests. Falls, in closing, mentioned biologic reactions that are not 100 per cent accurate, but have stood the test of time and are useful.

Quitman U. Newell, St. Louis: **Transmigration of the Human Ovum.**—Results of studies by the author were cited. Two pregnancies resulting from transmigration of the ovum were reported in a patient who had had the right ovary and left tube removed. The possible explanation of the process of transmigration of the ovum was given.

Fred L. Adair, Chicago, discussed external and internal transmigrations of the ovum. By way of proof of external transmigration, he mentioned the occurrence of ectopic pregnancy on the opposite side from the ovary of recent ovulation, pregnancy in the opposite side of the bicornuate uterus and after operation for the removal of the opposite organs. The subject is of interest because of its association with the problem of fertilization. He included a consideration of the function of the cilia and fimbria of the tube as well as the muscular action of the tube and ovary. In these cases he feels that there is a synchronization of the activity of the organs with endocrinal activity. **Joe V. Meigs,** Boston, reported another case of transmigration. **James L. Raycraft,** Cleveland, reported transmigration after plastic surgery on the remaining opposite tube and ovary. **A. J. Rongy,** New York City, mentioned some points in such a case. **David Hadden,** Oakland, Calif., outlined possibilities of pregnancy following errors in surgery. **George M. Shipton,** Pittsfield, Mass., also gave examples of pregnancy after surgical procedures.

C. O. McCormick, Indianapolis, Ind.: **Effects of Obstetrical Anesthesia on the Newborn Infant.**—Apnea is the one common ill effect of the various forms of modern obstetrical analgesia, except those of local infiltration. This frequently observed effect is perhaps largely responsible for the belief that analgesia routinely jeopardizes the infant. The reports of Schreiber and of Cole have done much to foster such an attitude of apprehension. Recent studies, particularly those of Kotz, demonstrate that the methods of relief in obstetrics of paraldehyde administration and the Gwathmey method have more favorable effect on the newborn. Comparisons of initial weight loss, recovery of birth weight, and temperature curve of newborn infants where various methods of analgesia had been used in the mother were demonstrated. Several charts were shown to illustrate the comparative results.

Emmett D. Colvin, Atlanta, Ga., discussed the importance of evaluation of all factors where drugs were used for obstetrical analgesia. He urged that one keep in mind the possible influence of drugs on the uterus to produce inertia. With many analgesics operative delivery becomes necessary; hence the possibility of more birth injuries. Colvin presented a series of cases where nembutal and paraldehyde were used for analgesia. He reviewed the results in this series, considering success of amnesia, results with length of labors, type of deliveries, apnea in infant, and behavior of infant after delivery. **William Wayne Babcock,** Philadelphia, remarked on the possibility of central nervous system changes in the child after analgesia. **Ward F. Seeley,** Detroit, spoke of the possible brain changes of a permanent nature in the newborn child. These so-called "devastation areas" in the brain may result without primary mortality. He expressed the opinion that initial weight loss was of little importance in this observation. **Grandison D. Royston,** St. Louis, indicated that most apnea of the newborn was the result of delay in delivery. Opiates do depress the respiration. He cited satisfactory results in the use of hyoscine and barbiturates. **Fred L. Adair,** Chicago, stated that the barbiturates do depress the respiration in the newborn. Delay in establishment of respiration is of great importance. **George W. Kosmak,** New York City, spoke in particular of some aspects of analgesia and possible effect on the newborn. Closing remarks by McCormick, covered the points of discussion.

A. J. Rongy and **A. B. Tamis,** New York City: **The Palatal Arch and the Pelvis; a Preliminary Report.**—The authors considered the female pelvis, its shape and form. Does it conform to general body configuration? Do the bony cavities have a definite relationship characteristic of the individual? Does the formation of the palatal arch give us a clue to the type and kind of a pelvis a woman may have? The paper, based on a study made of the palatal arch in 74 patients, was the attempt of the authors to answer the above questions. The various measurements of the palate were carefully made and the capacity studied. The kind and type of labor were accurately recorded in this series of cases. The changes in the oral mucosa during early pregnancy were also observed. Factors indicating easy or difficult labor were tabulated.

J. C. Litzenberg, Minneapolis, Minn., stated that everything about the pelvis is still unknown. One is unable to prove any definite relationship between the palative arch and the pelvis. Configuration of various parts of the body depends on the constitutional development of the patient. **Ralph E. Campbell,** Madison, Wis., discussed the development of the skull in relation to the endocrinological development of the patient.

W. T. Pride, Memphis, Tenn.: **Acidosis and Alkalosis in Gynecology and Obstetrics.**—Following studies of urine in cases of long labor in which evidence of acidosis was plain, studies of the blood CO_2 were made in labor. A series was obtained of the CO_2 of the blood at the end of the first, second, and third stages of labor. Following the obtaining of accurate data by blood studies of patients in labor, methods were considered whereby the correction of the degree of acidosis or alkalosis as indicated by CO_2 determinations might be brought out. Experimental studies were made on dogs to determine the strength of lactic acid solution, and the strength of soda bicarbonate solution that could be given safely intravenously. After it was determined that a 1 per cent lactic acid solution could be used, and that a 2 per cent soda bicarbonate solution could be used, it was then determined to a quantitative degree just how much of either solution was necessary to alter the CO_2 combining power of the blood to the normal range level.

Good results have been obtained by the use of these solutions in the work outlined by the authors. Examples of usefulness in long labors, and in retraction ring cases were given.

H. B. Van Wyck, Toronto, Canada, considered various procedures that may be carried out to prevent shock in labor. **E. L. Cornell,** Chicago, stressed various factors in the prevention of shock. **James E. Davis,** Ann Arbor, Mich., advised that the problem of shock often was a matter of distribution of blood mass in the body of the patient. Pride, in closing, mentioned the quantity of the solutions that might be necessary to give the desired effect in acidosis and alkalosis.

Clifford B. Lull, Philadelphia (by invitation): **Pubertas Praecox Due to Ovarian Tumors.**—The author expressed his purpose in the essay to call attention to the fact that ovarian tumors are the causative factor in precocious puberty. He reported in this paper what he believes to be the youngest patient ever operated upon for a granulosa cell tumor of the ovary with immediate reversion to normal infantile tendency. The second case he reported was of a follicular cyst of the ovary at 20 months of age, with definite signs of puberty. This patient also returned to normal following operation. Photographs of the patients and histologic sections were shown.

James E. Davis, Ann Arbor, Mich., mentioned the unusual fact of a presentation of two cases in patients of early age, with unusual sex development. He discussed phases presented in these two cases. Davis pointed out the life periods of granulosa cell activity; namely, (1) to the age of puberty, with precocious sex development; (2) period of fertility, with 85 per cent of cases showing abnormal bleeding and many with hyperfemininity; (3) postmenopausal period, with psychic changes and signs of sex rejuvenation. Malignancy seems to be present in 25 to 30 per cent of granulosa-cell tumors. These tumors show many histologic differences and various stages of development. **H. M. N. Wynne,** Minneapolis, discussed the presentation and mentioned points in a case. Due to the small number of these tumors, he suggested a national register where they might be recorded. **Joe V. Meigs,** Boston, mentioned the problem as not a common one. He told of the difficulty in differentiating between types. Both types have granulosa cells and theca cells. Precocious puberty is also associated with hypothalmus tumors, as in Albright's syndrome with brown spots, bone cysts, and precocious puberty. **Frank R. Smith,** New York City, discussed the effect of x-ray therapy in treatment of granulosa cell tumors. The results in general are bad. Lull, in closing, stated there was no uterine enlargement in either of these cases and no brown spots on patients.

E. L. Cornell, Chicago: **Objections to Induction of Labor in Normal Pregnant Women.**—The discussion was limited to normal pregnant women. He mentioned the complications that may arise from induction, and a résumé of 200 consecutive cases in private practice was given. Particular attention was paid to the size of the baby in the cases, from seven days before term until thirty days after the date of term. The conclusion reached was that it is seldom justifiable to induce labor in a normal pregnant woman.

John H. Moore, Grand Forks, N. D., illustrated cases of induction with some unsatisfactory results, such as excessive bleeding and delayed labor after ruptured membranes. He advised against assuming responsibility of induction for the sake of convenience. **Buford G. Hamilton,** Kansas City, Mo., cited cases of induction of labor with early rupture of the membranes and failure of labor to follow soon. He stated that the hazards are too great unless a definite indication

is present. **George W. Kosmak,** New York City, spoke of the number of papers presented for publication on the subject, "Induction of Labor." **Albert W. Holman,** Portland, Ore., presented a series of 1,163 cases of induced labor with figures on fetal and maternal mortality. **Herman B. Van Wyck,** Toronto, Canada, contributed to the discussion on the propriety of induction of labor. **A. B. Rongy,** New York City, indicated his ideas on the problem of a patient's being overdue and stated that induction of labor was never indicated for the sake of convenience. **George F. Pendleton,** Kansas City, Mo., spoke of induction and its features of responsibility involved. **Irving W. Potter,** Buffalo, N. Y., spoke of his attitude toward induction. He considered the process of effacement of the lower uterine segment. Cornell, in closing, again called attention to the normal cases only included in his essay.

Ralph E. Campbell, Madison, Wis.: **The Repair of a Series of Complete Tears of the Sphincter Ani With Extension up the Posterior Vaginal Wall by the Warren Vaginal Flap Operation.**—The author presented the steps in the vaginal flap technique for repair of complete laceration of the pelvic floor. The operation differs from the original Warren technique. Success of the operation depends on good blood supply, careful pre- and postoperative treatment, and not too much tension on suture lines. The operative technique was illustrated by lantern slides. Particular attention was given to preparation of the vaginal flap, the repair of vaginal wall above the flap, the closure of the levators, the closure of the sphincter and anal mucosa, and the skin closure. The method of removal of the remainder of the flap was described. Postoperative treatment was outlined. A series of 39 cases was presented with 95 per cent satisfactory results in 37 out of 39 cases.

Wm. F. Mengert, Iowa City, Ia., pointed out the advantage of the flap operation in eliminating raw areas in the rectal wall. He also considered the results with mobilizing and drawing down the rectal wall to eliminate raw areas in the rectal wall. He reviewed the results in eleven cases treated in this manner. **Fred L. Adair,** Chicago, spoke of the results as presented being mostly in older women. He stated that the best time to make such repairs is at the time of delivery. **Channing W. Barrett,** Chicago, noted that complete lacerations should be repaired at delivery. He also stated that in most cases the rectal wall could be mobilized and brought down.

James R. McCord, Atlanta, Ga.: **President's Address.**—McCord spoke on a subject to which he has always devoted much time and thought, that of maternal mortality in the Southern states. He showed the high maternal mortality both in white and negro women. A series of 97 maternal deaths in colored obstetrical patients was presented. By careful analysis he divided the series into those that were preventable and those nonpreventable. Of the preventable deaths he listed those in which the possibility of prevention rested with the patient and those in which the physician was at fault. He also listed the deaths in the series from nonobstetric causes. It was well shown by him that negro women in the South are bad obstetric risks. Closely related to the problem of maternal mortality is the economic situation in the South. The speaker gave a most enlightening résumé of the economic situation in the Southern states.

Erwin O. Strassmann, Houston, Texas: **The Theca Cone and Its Tropism Toward the Ovarian Surface, a Typical Feature of Human and Mammalian Follicles. Thesis Awarded the Foundation Prize.**—This paper is a summary of microscopic research done from 1921 to 1939. The findings presented are based on 18,000 microscopic sections of ovaries in four mammalian orders: primates, carnivora, rodentia and ungulates. The diameter of human growing follicles and their

distance from the ovarian surface were measured micrometrically. It was shown that in the early stages of follicular growth up to a diameter of 0.25 mm., there is a descent of the follicles from the albuginea toward the hilus and that there is an ascent of the larger follicles back toward the surface. This ascensus begins with the appearance of the theca layers. Examination of the theca layers shows that the growth is an eccentric one. There is a one-sided thickness of the theca interna toward the ovarian surface. This forms a wedge-like theca interna cone with a triangular cut surface which always points to the nearest part of the ovarian surface. This infiltrating growth plows a path for the follicle through the stroma and albuginea. The granulosa layer frequently adopts the shape of the theca cone. In all mammalian species the theca cones grow divergently toward the ovarian surface, except in the horse ovary, where the theca cones grow convergently toward the only free spot, the "ovulatory pit." To demonstrate the theca cone which is present only in actually growing follicles, it is necessary to cut serial sections which are cut perpendicularly to the ovarian surface.

Stuart B. Blakely, Binghampton, N. Y.: **The Psychology of Pregnancy.**—The author compared male and female psychology. The desire for a baby is basic in woman's nature and cannot be successfully denied. Causes of the mental state of pregnant women, responses of the psyche to pregnancy, prominent in the early months, are changes in disposition, cravings or aversions, and nausea and vomiting. Included in the essay are other changes which the author deals with as psychic, including sexual personality, emotions of resentment and anger and anxieties and fears. He considered the pregnant woman's attitude toward abortion, abortifacients, and abortionists. The attitude of the laity toward obstetrics and the obstetrician was discussed. Finally, dreams in pregnancy as well as the esthetics of pregnancy and mental hygiene of pregnancy were covered.

I. W. Potter, Buffalo, N. Y., stated that physiologic changes of pregnancy cause a number of disturbances of pregnancy and must be considered inciting factors. **R. T. La Vake,** Minneapolis, stressed the importance of understanding as well as possible the psychology of pregnancy. He discussed the attitudes toward abortion and stated that he does not feel that scruples toward abortion are on the wane. Blakely, in closing, considered nausea and vomiting of pregnancy to be largely psychic. He also states that he believes induced abortions are extremely common.

E. Lee Dorsett, St. Louis: **Reoperation Analysis of 125 Gynecologic Cases.**—The unsatisfactory results following gynecologic operations were discussed. Some of these poor results were found to be due to the formation of postoperative adhesions that caused partial intestinal obstruction, and from which patients suffered almost constant pain. The author feels that some of the unsatisfactory results with the formation of adhesions were due to improper time selected for performing an operation on certain cases of inflammatory disease; operating upon cases of salpingo-oophoritis in the acute stages; the rough handling of tissues; too conservative measures in certain cases of chronic pelvic inflammatory disease; the failure to cover properly all raw surfaces following operative procedures; the improper use of drains; the failure to select the proper type of operation to cope with the situation at hand; the habit of using routine procedures and trying to make one operation fit every case. All these factors and many more are reasons why some of our unsatisfactory results follow gynecologic operations. One hundred and twenty-five cases were presented. The essayist was the original operator in a certain percentage of cases; the remainder had been operated on by other men. Some of these cases had two, three, and four laparotomies.

F. Smead, Toledo, Ohio, stated the unsatisfactory situation of having to operate on a patient a second time. He stressed the careful selection of patients for operation, the careful handling of the parts, the production of no raw surfaces. In removing the appendix one should be particularly careful. Following gynecologic surgery endometriosis is frequently the cause of reoperation. **William H. Vogt,** St. Louis, considered the matter of preoperative preparation. With the use of more local anesthesia, more careful handling of the tissues results. **Adam P. Leighton,** Portland, Me., reported some experiences of operative results in postoperative cases. **George W. Kosmak,** New York City, advised the more extensive use of the transverse abdominal incision, as well as the reduction of traction to a minimum. Dorsett, in closing, mentioned the part played by endometriosis in reoperation of cases. He also spoke of the importance of wound-closure methods as a part of important operative procedures.

David Hadden, Oakland, Calif.: **Clinical Experience With Testicular Extracts in Obstetrics and Gynecology.**—The essayist stated that our present knowledge justifies a report upon the use of an extract, the mention of which, a few years ago, would have subjected one to criticism. This report was also a word of appreciation of one, who, the author states, would have gone far in endocrinology if his life had been spared. The anatomical and physiological reasons that seemed to justify the preparation and the use of such an extract in gynecology were briefly given. The factors that led to its experimental use in the vomiting of pregnancy and the satisfactory results are considered. Its wider application in such conditions as menorrhagia and acne came as a result of failure with more supposedly orthodox preparations. The author described the preparation of the extract as devised by Moore and Archibald.

W. A. Coventry, Duluth, Minn.: **Actinomycosis of the Ovary.**—The author reported one case of actinomycosis of the ovary with case history, operative findings, surgical pathology, and subsequent course of the patient to date. He reviewed the cases of actinomycosis in Duluth hospitals. There were three cases in one hospital and four in another. Of the seven cases, three involved the glands of the neck. In three cases the patients are still living. Three cases involved the intestinal tract; all are dead. The one case of actinomycosis of the ovary is still living. In the literature there are less than 100 cases reported. The author gave a brief review of the literature. A great question in the cases in general is the primary source of infection.

Frederick H. Falls, Chicago, showed the predominance of right-sided involvement in actinomycosis of the ovary. This may extend to the opposite side after the first operation. He described the type of growth of the organism. He also considered recurrent cases after operation and reported his recent experiences in such a case. **Lewis F. Smead,** Toledo, Ohio, reported his experience in a recent case. **George F. Pendleton,** Kansas City, Mo., brought up questions concerning the subject.

Frank R. Smith, New York City: **Nativity and Carcinoma of the Cervix.**—This paper covered a statistical study of the nationality incidence of cervix carcinoma at Memorial Hospital. The patients with carcinoma of the cervix were compared as to nationality with the patients presenting other types of lesions and with a cross section of the gynecologic clinic. A discussion of the reasons for the findings was included, although these reasons are theoretical rather than statistically proved.

Herbert E. Schmitz, Chicago, in discussing the cases, presented the picture of nationalities in Chicago. He compared the incidence of carcinoma in the various nationalities and races found there. He also included in his discussion a consideration of the effect of radiation on vaginal tract bacteriology.

C. O. McCormick, Indianapolis, Ind., presented motion pictures of **The Use of Rectal Ether Anesthesia.**

THE TWENTY-THIRD ANNUAL MEETING OF THE AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION

PAUL HOLINGER, M.D., CHICAGO, ILL.

THE twenty-third annual Meeting of the American Broncho-Esophagological Association was held June 5, 1940, at the Waldorf-Astoria Hotel, New York City. **Lyman Richards,** Boston, presided.

In his presidential address **Richards** traced the development of broncho-esophagology, and the relation of this development to the training of new men in the specialty. He stressed the importance of the mastery of technique of peroral endoscopy which was first developed by otolaryngologists who devoted only a portion of their time to endoscopy. However, the necessity of constant practice and the advantage in experience gained through specialization in this work have led him to believe that in the future more men will devote their entire time to this field. Opposed to this, mention was made of the high degree of skepticism which still exists in the minds of certain internists and surgeons, in spite of the tremendous increase in both the diagnostic and therapeutic phases of broncho-esophagology. On the other hand, Richards justified the position of other internists and surgeons who have invaded the field of peroral endoscopy because of their intimate knowledge of problems dealing with thoracic pathology.

New instruments were presented by the following members of the association:

Simon Jesberg, Los Angeles, presented a series of esophagoscopes which combined the sled type tip of the Haslinger esophagoscope with distal lighting. He also presented miniature 3 and 4 mm. infant bronchoscopes as well as a protecting mask and interchangeable lenses for glasses which can be used in endoscopic work.

Sam Roberts, Kansas City, Mo., presented a bronchoscopic biopsy forceps similar to laryngeal cup forceps, lengthened for bronchoscopic use.

Arthur Penta, Schenectady, N. Y., presented a pair of electrically heated glasses to be used in endoscopic work. The heating coil of wire, fused into the glass, prevents the lens from fogging.

Several case reports were presented:

Ernest M. Seydell, Wichita, Kan., demonstrated roentgen films of a 14-month-old infant who had had symptoms of an esophageal foreign body. The roentgen films showed a disklike object, which, on anteroposterior projection, appeared to be located in the cervical esophagus. Negative esophagoscopic examination led to further studies and the disk was proved to be a center of ossification of the sternum. The presentation was discussed by **T. E. Carmody,** Denver, **L. H. Clerf,** Philadelphia, **C. E. Pitkin,** Cleveland, and others who reported having had similar experiences.

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Louis H. Clerf, Philadelphia, reported a case of a tuberculous periesophageal abscess which had produced stenosis of the esophagus. The roentgen findings had revealed a marked esophageal stenosis suggestive of an esophageal neoplasm. Esophagoscopic examination demonstrated a swelling of the posterior wall of the esophagus which was topped by a yellowish pustule. When opened, 30 c.c. of pus were drained in which many tubercle bacilli were found. There was no demonstrable evidence of tuberculosis elsewhere and the patient made an uneventful recovery. A year later an esophagoscopic examination showed the esophagus to be normal. The process was considered to be due to the erosion of a tuberculous lymph node into the esophageal wall.

Leroy A. Schall and **Louis Johnson**, Boston (by invitation), reported the case of a 5-month-old infant who had had respiratory difficulty dating from birth. A bronchoscopic examination revealed a tracheal compression at the carina, and, since the child obtained relief from the dyspnea while the bronchoscope was in place, a tracheotomy tube was inserted. The infant died because of a profuse hemorrhage and the autopsy revealed a double aortic arch, the right and left arches constricting the trachea. The paper was discussed by **Paul Holinger**, Chicago, **A. E. Hammond**, Detroit, and **C. L. Jackson**, Philadelphia, who reported similar cases of tracheal and bronchial compression due to cardiovascular anomalies.

George O. Cummings, Portland, Me., described the treatment of a traumatic tracheal atresia by means of graduated core molds. The patient had received a crushing injury to the trachea in an automobile accident, destroying both airway and voice and necessitating a tracheotomy. A tracheal occlusion developed which was demonstrable on roentgen films. The trachea was opened under general anesthesia, and through the use of core molds the tracheal lumen was reestablished. **Chevalier Jackson**, Philadelphia, stressed the importance of starting treatment early in these cases.

Porter Vinson and **W. E. Pembleton**, Richmond, Va. (by invitation), presented the case of a patient 63 years of age who was having repeated severe pulmonary hemorrhages. Bronchoscopic examination revealed a mass in the right bronchus which was removed and proved to be a hilar lymph node with tiny areas of calcification. The microscopic examination of tissues taken from the bronchial wall at the point of ulceration showed tuberculosis. The bronchial lumen was reestablished by the removal of tissue and the patient made a complete recovery.

The following papers were read:

Clyde A. Heatly, Rochester, N. Y.: **Surgical Management of Intractable Cardiospasm.**—Heatly mentioned the various theories of the etiology of cardiospasm, and described the types of operations which had been suggested and performed for relief of intractable cases. He presented two cases of patients who had not obtained relief in the usual manner following dilatation on whom a surgical anastomosis of the lower end of the esophagus and the cardiac portion of the stomach in the manner of the Finney pyloroplasty had been done. Through a left midline incision the peritoneum had been reflected from the diaphragm and the esophagus. The cardia was drawn down by a tape passed between the cardia and the esophagus, and the lateral anastomosis followed. One of the patients was 79 years of age, the other 24 years. In the first the esophagus remained dilated following the operation, but there was an easy flow of barium into the stomach. The dilatation of the esophagus in the second patient was reduced and there was likewise an easy flow of barium into the stomach. The paper was discussed by **Porter Vinson**, Richmond, Va., **M. F. Arbuckle**, St. Louis,

Gordon Berry, Worcester, Mass., and **C. A. Heatly,** Rochester, N. Y. Other cases of surgical relief of cardiospasm were presented by the discussors who all stressed the exhaustion of conservative methods of relief before resorting to surgery. Uniformly good results were reported with the use of the method described by Heatly. Unsuccessful results followed other surgical measures.

Millard F. Arbuckle, St. Louis: **Bronchoscopic Treatment of Lung Abscess.**—Reference was made to the published opinions of numerous thoracic surgeons regarding their methods of treatment of patients with lung abscesses. Arbuckle stated that the importance of bronchoscopy was seldom stressed. He pointed out that the role of bronchoscopy in the treatment of lung abscess was in establishing endobronchial drainage through removal of granulation tissue which is often found between the main bronchus and the abscess, and directing an aspirator to aspirate the contents of the abscess itself. Of 43 cases in Arbuckle's series of acute, subacute, and chronic lung abscesses, whose duration varied between two weeks and three and one-half years, 19 recovered completely and 4 showed satisfactory improvement on bronchoscopic aspiration; whereas, 20 failed to recover or improve on bronchoscopic aspiration alone. The ages of the patients ranged between 3½ and 65 years. Arbuckle stressed the use of extra length aspirating tips, the removal of granulation tissue plugs which had been visualized by lipiodol, and the control of hemorrhage through the use of cocaine and adrenalin. Arbuckle also stressed the necessity of a thorough preliminary examination to establish the location of the cavity before bronchoscopy. **C. L. Jackson,** Philadelphia, in discussion, stressed the fact that one should not consider bronchoscopy versus surgery in the treatment of lung abscess, but that the two specialties should work in close harmony with one another in the management of this pulmonary disease. **Porter Vinson,** Richmond, Va., described the insufflation of powdered sulfanilamide into the infected lung as a means of treatment, stating that it had been frequently used prior to further surgical procedures in a number of cases of lung abscess. Arbuckle closed the discussion by mentioning that avertin had been used throughout as an anesthetic and that there had been no fatalities during or following any of the bronchoscopic procedures.

Samuel Pearlman, Chicago: **Sarco-carcinoma of the Esophagus. Is There Such an Entity?**—Pearlman analyzed 17 cases reported in the literature and 8 additional cases of his own of so-called carcinosarcoma of the esophagus. He illustrated the anaplastic nature of certain of the squamous-cell carcinomas in which the boundaries between carcinomatous and sarcomatous elements were indistinct. He concluded that in his cases the pathology was that of a primary carcinoma of the esophagus associated with an inflammatory process which had compressed the epithelial cells to give them a spindle shape. The manner in which the cells were cut likewise influenced the appearance of the specimen as seen through the microscope. For these reasons Pearlman felt that the so-called sarco-carcinoma was a questionable entity.

Chevalier L. Jackson and **George S. McReynolds,** Philadelphia (by invitation): **Anesthesia for Peroral Endoscopy.**—The authors, through a study of questionnaires, reviewed the current practice in anesthesia for direct laryngoscopy, bronchoscopy, esophagoscopy and gastroscopy throughout the country and described the methods of anesthesia now in use in the Department of Broncho-Esophagology at Temple University. The purpose of their study was to consider the safety and efficiency of the various anesthetics now in use and to determine, if possible, the anesthetic which would cause the least discomfort to the patient both

as regards the endoscopic procedure and the anesthetic. Eighty-six, or approximately 80 per cent, of the questionnaires sent out were returned. Of these, the majority stated the use of some type of premedication. The principal types used were morphine and atropine or morphine and some type of barbiturate, while only two used morphine and scopolamine. A large majority of the returns indicated that most endoscopists used a general anesthetic for some of the procedures, the indications being the age of the patient, unusual size or shape of a foreign body, or the lack of an operating team. Seventeen of the 86 never used a general anesthetic. Of the local anesthetics used, cocaine, pontocaine, and larocaine were the anesthetics of choice in the order mentioned. The procedure of application of the local anesthetic varied in detail with almost every clinic. The usual procedure was that of a preliminary spray of the pharynx with the topical anesthetic, followed by painting or swabbing the posterior pharyngeal wall and the insertion of sponges on curved sponge carriers into the pyriform sinuses. The method in use at the present time at the Jackson Clinic is that of premedication with morphine and atropine and occasionally a barbiturate. In children no anesthesia is used and in adults the anesthetic is first sprayed into the pharynx and then fractionally instilled onto the larynx and into the trachea with a laryngeal syringe. This procedure is used in adults for the procedures of direct laryngoscopy and bronchoscopy, but for esophagoscopy the pharynx is merely sprayed. In gastroscopy the Schindler anesthetizing tube is passed into the esophagus for the administration of the local anesthetic.

M. C. Meyerson, New York City: **Bronchoscopy in Tuberculous Children.**—Meyerson discussed the findings in 29 children suffering from pulmonary tuberculosis who had been referred for bronchoscopic examination during the year. The indications were those of atelectasis, noisy breathing, the localization of an active lesion, or the removal of secretions for bacteriologic examination when the examination of the stomach contents and feces had been negative in suspicious cases. Thirteen of the 29 patients had positive findings. These differed little from the endoscopic findings of adults with pulmonary tuberculosis. In 7 of the 29 patients an obstruction of the tracheobronchial tree by compression of mediastinal glands was found. Atelectasis was present in 4 of the patients; secretions produced the bronchial obstruction and atelectasis in 3 cases, and granulation tissue in 1 case. In 9 cases tubercle bacilli were recovered from the bronchoscopically removed secretions when the sputum examinations had been negative prior to the bronchoscopy. Meyerson felt that the ulcerogranulomatous lesion is not seen as commonly in children as it is in adults.

George R. Brighton, New York City: **Laryngotracheobronchitis.**—The author mentioned the increasing tendency of designating all cases of laryngeal obstruction in children as due to laryngotracheobronchitis. He limits the diagnosis to those cases requiring surgical relief. Of 27 cases reported, the majority had been observed during the past four years with a death total of 11 cases, or 40 per cent mortality. The average age of the patients was 27 months; the youngest, 11 months. The author felt that sulfanilamide had not influenced the death rate in his series, 6 of the 10 patients receiving sulfanilamide having died. Routine treatment was that of humidified air, oxygen, or oxygen and helium, with tracheotomy the method of choice if operative relief became necessary. The disease was compared to laryngotracheobronchitis in chickens, the disease in chickens having been established as due to a filterable virus. The lymphocytosis and other features of the pathology were both grossly and microscopically similar to those seen in chickens. The author feels, therefore, that laryngotracheobronchitis may be due to a virus.

F. W. Davison, Danville, Pa.: **Some Observations on the Control of Humidity and Temperature in the Oxygen Tent.**—Davison made detailed studies of various factors governing the atmospheric conditions in oxygen tents and described the physiologic effect due to the abnormal conditions within the tent. He demonstrated an ingenious way of controlling the humidity within the tent through the use of a special attachment which permitted the inflowing oxygen to be supersaturated with moisture before being introduced into the tent. The moisture is supplied by a mechanical humidifier, thus avoiding the heat ordinarily produced by croup kettles. He described the use of this apparatus for treatment of acute laryngotracheobronchitis and presented the results of cases treated in this manner.

Herman E. Bozer, Buffalo, N. Y.: **Bronchial Collapse Without Clinical Signs of External Pressure.**—Bozer presented three cases of bronchial collapse which appeared to be due to the inability of the cartilaginous framework of the bronchus to maintain the lumen under certain physiologic conditions. In each of the 3 cases the left bronchus was involved and in 2 of the cases an atelectasis was present. In these 2 cases breath sounds could be heard satisfactorily over the involved areas when the bronchoscope was held in place or the bronchus held patent by means of forceps. In the third case relief of the cardinal symptom, dyspnea, was obtained through the use of adrenalin. The collapse in this case, as the author suggested, might have been on the basis of a bronchospasm or a collapse of the bronchus due to the strain which accompanied a severe cough.

NORTHERN SURGICAL SOCIETY

JAMES HINDMARSH, STOCKHOLM, SWEDEN

THE twenty-second meeting of the Northern Surgical Society was held in Oslo, Norway, June 29 to July 1, 1939. The president was Professor Emeritus P. Bull; the general secretary, Professor E. Dahl-Iversen.

Thesis I. Diabetes and Surgery.—The Discussion was opened by **Torben G. Knudtzon,** Copenhagen; **H. C. Hagedorn,** Copenhagen; **J. P. Strömbeck,** Stockholm; and **Per Hanson,** Oslo.

T. G. Knudtzon, Copenhagen, reported 635 cases of diabetes among surgical patients who had been treated at the two departments of surgery at the Municipal Hospital in Copenhagen during a twenty-year period from 1919 to 1939. Of these cases, 347, or 55 per cent, were of special types often associated with diabetes, such as gangrene, carbuncle, etc.; while 176 cases, or 28 per cent, were associated with accidental conditions, such as injuries, acute surgical abdominal diseases, etc. The mortality for the whole group was 19 per cent. During the first five-year period, before the introduction of insulin, the mortality was 26 per cent. It fell to approximately 11 per cent during the second five-year period, but rose again to 18 per cent during the last five years.

The mortality of diabetic gangrene was especially high in febrile cases and in patients with severe diabetes. The majority of cases were treated conservatively. The importance of prophylactic measures was emphasized.

In the cases with carbuncle the mortality was highest when the lesion occurred on the back of the neck. The author recommended excision of such carbuncles and treatment to control the diabetes.

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Among the abdominal conditions, diseases of the appendix, gall bladder, and pancreas were most important. In appendicitis severe pathologic changes occurred early. In cases of appendical abscess the author advised careful control of the diabetes and, whenever possible, early incision and drainage of the abscess. Cholecystitis was a serious complication among diabetic patients, and the author recommended operation at an early stage in the presence of gallstones or cholecystitis.

For pregnant patients the author advised therapeutic abortion if the diabetes were severe.

In cases of accidental injuries the diabetes frequently became more difficult to control, but usually responded well to proper antidiabetic treatment.

Nitrous oxide anesthesia is preferred for diabetic patients who require surgical treatment for some associated condition. Spinal anesthesia is satisfactory in certain cases, but ether and chloroform should be avoided.

Operations were performed upon 387 of the patients (61 per cent). Although the risk has been reduced by the use of insulin, severe surgical procedures should be carried out upon diabetic patients only if the indications are positive. Among such patients, arteriosclerosis and myocardial damage frequently occur at an early age. Pneumonia, sepsis, and arteriosclerosis were the most frequent contributory causes of death. The author stated that in the future the mortality from sepsis might be reduced, but he expected an increase in the number of deaths from arteriosclerosis and probably no change in the mortality rate from pneumonia.

H. C. Hagedorn, Copenhagen, pointed out that, since the introduction of insulin, the prospects for patients suffering from diabetes associated with surgical complications are almost as good as for patients free from diabetes. The development of surgery and the accommodations of modern hospitals have contributed to the favorable results. The characteristic progress of the complications is not, as one may believe, due to the high percentage of grape sugar present in the tissues, but it is probably caused by a change in the cellular metabolism which reduces the amount of carbohydrate and fat in the tissues so that the conditions are far from normal. The rapid effect of insulin on obstinate wounds supports this assumption. Another factor may be the accumulation of normal or abnormal metabolic products. Injury to the nerves and vessels constitutes another important point, and consideration of the problem from this angle might throw some light on the unusual progress of many complications in diabetic patients.

The author called attention to similarities between diabetes and other endocrine diseases, such as myxedema and Addison's disease. He advised proceeding cautiously in the treatment of diabetic gangrene, especially if the patient's general condition is improving.

J. P. Strömbeck, Stockholm, stated that the increased duration of life resulting from the introduction of the use of insulin has added to the number of diabetic patients coming for surgical treatment. Cases of diabetic gangrene have been increased.

Narcosis and other conditions associated with an operation disturb the carbohydrate metabolism more in diabetic than in nondiabetic patients, but the administration of carbohydrate and insulin reduces the risk to such an extent that it is almost the same in both instances. Dehydration and chloride deficiencies must be eliminated. The author expressed a preference for nitrous oxide and ether anesthesia, and he stated that chloroform, avertin, and evipan were to be avoided. Insulin should be given to all diabetic patients coming for surgical treatment, and may be given by continuous intravenous drop infusion if necessary. Excessive amounts of insulin, leading to hypoglycemia, carbohydrate deficiency, and hepatic insufficiency, are especially dangerous.

The proper use of insulin has lowered the mortality from diabetic gangrene and has made possible a more frequent use of conservative therapy. Even so, the end results of diabetic gangrene are not satisfactory. Prophylactic treatment is of great importance. In diabetic patients with infections, carbohydrates and insulin should be given in adequate amounts, foci of infection should be eliminated as early as possible, and proper surgical remedies for infection should be applied.

Per Hanson, Oslo, reviewed his experience, covering the surgical treatment of 55 cases of diabetes which he treated medically during the period 1936 to 1938. He stated that it is important to keep the total caloric intake low, but to give carbohydrates in large quantities. It is preferable to give repeated, small doses of insulin rather than a few large doses. Five of the 55 patients died, but in no instance was the death attributed to the diabetes or to treatment with insulin. Generally, there were remarkably few complications.

Olof Arnell, Stockholm, gave a report concerning the surgical treatment of patients with diabetes, based upon experiences at the Maria Hospital, Stockholm. A series of 1,782 cases of diabetes had been treated during the years 1910 to 1938, and 358 of these had been operated upon, with a mortality of 18.4 per cent. Gangrene was present in about 10 per cent. Acute abdominal diseases often provoked less pain in diabetic patients than would be expected from the severity of the condition. The mortality in cases of appendicitis was very high; and cholecystitis was more liable to be severe and carried a greater risk of perforation than in nondiabetic patients. Absence of sugar from the urine does not always exclude the presence of diabetes. The urinary test for ketones never should be neglected. Before the introduction of insulin the mortality was 10.2 per cent higher than the recent mortality rate. Since the beginning of the use of insulin there have been no deaths from diabetic coma.

Fredrik Therkelsen, Copenhagen, discussed the use of a high carbohydrate diet and insulin in surgical patients with diabetes, and reported 12 cases. Urinary ketones disappeared rapidly and the diabetes was easily kept under control. Acidosis did not occur, and there were no complications due to insulin. The surgical treatment was conservative.

H. Thelander, Stockholm, stated that the use of insulin has increased the number of pregnancies in diabetic females. At the same time it has improved the prognosis so that the mortality is scarcely higher than in nondiabetic women. The internist and obstetrician should collaborate as closely as possible. Cesarean section should not be performed unless the obstetrician considers it to be unavoidable. The infant mortality is still high among diabetic patients, so the condition should be carefully controlled in the child.

Abraham Troell, Stockholm, discussed the problem of diabetes and accidents. Glycosuria may occur after trauma to any part of the body, but it is of no significance. Genuine diabetes may occur following peripheral trauma in patients previously manifesting no symptoms of the disease. According to the author, this fact indicates a relationship between the injury and the diabetes in those cases, even though there may have been an hereditary tendency toward the disease or a latent diabetes. Diabetes tends to delay healing after physical injuries, and therefore warrants compensation for damage.

E. Lundberg, Drottningholm, stated that in cases of pregnancy in diabetic women therapeutic abortion must be performed in the presence of slight indications, unless some contraindication exists. Infant mortality is not much lower today than it was before the introduction of insulin. It is important to maintain the mother's blood sugar level as nearly normal as possible during pregnancy.

J. Tillgren, Stockholm, stated that in cases of acute surgical diseases associated with diabetes, an extra dose of insulin should be administered previous to the operation, even if the patient is unable to take food. Mild cases of diabetes should be allowed a diet without insulin as soon as possible after the operation. Full diet is not advocated and, even in children, it must be considered an excess.

Uno Carlborg, Stockholm, reported his experiences with oscillometric examinations in 123 cases of diabetes. Of this group of patients, 34 per cent manifested pathologic oscillograms in the leg. Gangrene was present in 10 patients (all with pathologic oscillograms), and 36 patients had subjective and objective symptoms in the form of pain, sensation of cold, etc.

Abraham Troell, Stockholm, expressed the opinion that the operative mortality in patients with diabetes would be reduced if larger doses of insulin were given prior to operation. He advised the administration of 10 to 20 units of insulin, and the injection of glucose solutions subcutaneously and by rectum, two or three doses being given in a day.

Esben Kirk, Copenhagen, stressed the importance of the test for bicarbonate in the plasma in cases which are approaching or are actually in coma. The intravenous injection of an isotonic solution of sodium bicarbonate relieves acidosis without danger of alkalosis during the interval before the effects of insulin can be produced.

R. Romanus, Hälsingborg, discussed a series of 700 cases of diabetes treated during the years 1925 to 1937. Among these, there were 62 cases of gangrene. Only 26 patients were operated upon. The diet consisted of large amounts of fat and moderate amounts of carbohydrate.

A. Tallroth, Göteborg, recommended evipan for anesthesia in diabetic patients.

F. Saltzman, Helsingfors, discussed a series of 514 cases of diabetes treated at the Maria Hospital in Helsingfors during the period 1930 to 1939. Ten per cent of the cases had required surgical operation.

Johs Ipsen, Sönderborg, stated that in diabetic gangrene the temperature of the skin of the affected foot does not differ from that of the unaffected foot. This indicates that the gangrene is not due to a deficiency of blood supply and explains the favorable results obtained by conservative treatment in cases which are not too far advanced. Gangrene associated with arteriosclerosis requires different therapy.

In conclusion, **Knudtzon** stated that it seemed to be generally accepted that large quantities of carbohydrates should be given together with adequate amounts of insulin, and that acidosis should be prevented, or, if present, combated. **Strömbeck** warned against the use of an increased dose of insulin before operation in patients with well-controlled diabetes. **Hanson** emphasized that the caloric intake should be low under all circumstances and that carbohydrates should be given by mouth or by rectum. Only in cases of emergency should carbohydrates be given subcutaneously or intravenously.

Gunnar Nystrom, Borgå, reported 4 cases of malignant tumor of the kidney in children and discussed the pathologic anatomy and treatment of embryonal tumors. He stated that hematuria occurs in only about 10 per cent of such cases. The prognosis is worse than in cases of Grawitz tumors, the percentage of cures being not over 10 per cent at best. Three of the author's 4 patients died. The fourth was still alive a few months after operation. The author assumed that the tumors originate from the mesenchyma. In the discussion, **Borch-Johnsen,** Oslo, reported 1 patient still living eight and one-half years after operation, which had been performed at the age of 16 months.

Frans Sorensen, Copenhagen, summarized data based upon the observation of 250 cases of fibroadenomatosis of the breast. In more than 100 cases, treated partly with and partly without estrin, and in which histologic examinations had been made, it was found that the therapeutic effect of estrin was proportional to the amount of pathologic hyperplastic interlobular connective tissue. Examination after periods of one to four years revealed that one-third of the patients treated with estrin were subjectively and objectively free from symptoms. Malignant changes did not occur in any case.

John Hellstrom, Stockholm, related experiences with the operative treatment of diverticula of the urinary bladder. Since 1933 the author has operated upon 10 such cases: 9 males and 1 female. There was 1 postoperative death from coronary sclerosis. In 8 cases radical operation was performed by invagination of the diverticulum with the aid of Pean's forceps or by suction, after the bladder had been opened. In 2 cases one of the ureters opened into the diverticulum. In 1 of these a collar was left around the ureteral orifice, and this was sutured into the vesical defect resulting from extirpation of the diverticulum. In the other case a stone was present in the dilated ureter. Ureterolithotomy was performed and an anastomosis was established between the ureter and the diverticulum.

G. Levander, Köping, stated that he had operated upon 2 patients with good results. He advised an extravesical approach after having tamponed the diverticulum from within the bladder.

N. Backer-Gröndahl, Bergen, discussed the advisability of shortening the period of confinement to bed following operations. If the patient is allowed to be up as early as possible, the danger of thrombosis and embolism is decreased and nursing care is facilitated. The economic advantage is obvious. The author reported 435 patients who had been permitted to be up within 7 days following abdominal operations. Among the group there were 49 cases of gastric resection.

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Gunnar Bauer, Mariestad, reported 11 cases with a renal type of pain, but without other positive urologic findings, in which renal denervation (sympathectomy) produced relief. The pain had been present for months or years. There were no serious complications, and in 1 case there was a decrease of urinary casts after the operation.

James Hindmarsh, Stockholm, discussed the treatment of intussusception in children in a group of 66 cases. Between the years 1930 and 1934, 24 cases had been treated by trying to obtain reduction by the injection of a contrast medium enema under fluoroscopic control. Between 1935 and 1939, 42 cases were treated by immediate operation if the nonoperative reduction failed on the first attempt. The mortality for the entire group, among whom 47 cases were operated upon, was 7.6 per cent. During the first period the mortality was 16.7 per cent and during the later period it was 2.4 per cent. The author concluded that preliminary injection of a contrast enema reduced the risk of operation to a minimum.

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Ivar Moene, Bergen, reported a case of von Recklinghausen's disease associated with ganglioneuroma of the stomach in a 54-year-old man. Roentgen examination revealed a tumor on the lesser curvature which at operation proved to be a ganglioneuroma the size of an orange. The patient is alive and well one and one-half years after operation.

Gunnar Redell, Upsala, discussed the occurrence of ascending infections of the biliary tree following anastomotic operations carried out upon tne bile ducts. Reviewing 809 Swedish cases (1914 to 1937), he found that postoperative infections were very uncommon. He emphasized the importance of a large stoma, allowing unimpeded passage through the anastomosis. Anastomosis of the bile ducts carries less risk of infection than anastomosis of the gall bladder.

In the discussion, **Ph. Sandblom,** Stockholm, stated that in animals cholangitis always follows anastomotic operations. In human beings cholangitis is certain to be present in many cases without producing clinical symptoms and is usually found only at post-mortem examination. One may not draw conclusions, therefore, concerning the frequency of cholangitis merely on the basis of clinical symptoms. In reply, **Gunnar Redell** expressed the opinion that the results of animal experimentation are not entirely comparable to conditions found in human beings.

John Rö, Oslo, discussed the pathogenesis of pain occurring after cholecystectomy. He stated that 35 per cent of a group of patients complained of persistent pain following cholecystectomy. Most of these manifested a tonic spasmodic condition of the duodenum and an altered reaction to morphine. In normal patients the intraduodenal pressure increases slowly and only moderately after morphine; whereas, in patients with postcholecystectomy pain the drug evokes a rapid, marked increase in pressure associated with typical attacks of pain. The pain may be relieved by the administration of amyl nitrite or nitroglycerin.

Roar Ström, Drammen, discussed thyreotoxic affections of the liver. His experience included post-mortem examinations of cases of thyreotoxic affections and examinations of rabbits after prolonged administration of thyreotoxin. Liver function tests were applied to patients with hyperthyroidism before and after treatment as well as to healthy control patients. The rabbits were tested in a similar manner, and perfusion tests also were carried out on the surviving liver of rabbits. In the cases examined at necropsy and in the rabbits treated with thyreotoxin, morphologic alterations of the liver were observed. The galactose tolerance test is frequently positive in cases of thyreotoxic affections and the patients present an inclination toward fasting hypercitricemia and an abnormally increased alimentary citricemic load curve. The principal cause of decreased carbohydrate tolerance in cases of thyreotoxemia is an assimilation deficiency of the liver, a condition due to an action of the thyroid substance on the liver epithelium, irrespective of the quantity of glycogen present in the liver or of other morphologic alteration.

Thesis II. Intracranial Injuries Due to Blunt External Force and the Conditions Produced by Such Accidents. The discussion was opened by **Aarno Snellman,** Helsingfors; **Haakon Saethre,** neurologist, Oslo, and **G. Rövig,** Oslo.

Aarno Snellman, Helsingfors, reviewed 1,076 cases of skull and brain damage treated during the period 1932 to 1938 at the Red Cross Hospital of Finland in Helsingfors. In this group 275 (25.5 per cent) presented skull injuries. In 80 per cent there was evidence of an organic intracranial lesion, and in 30 per cent the intracranial damage was severe. Spinal puncture was performed in many of the cases, but usually not earlier than forty-eight hours following the trauma. Sub-

arachnoid bleeding was relatively common, even in slight injuries, and it increased in proportion to the violence of the trauma.

Cases with increased intracranial pressure were divided into two classes: (1) acute increase of intracranial pressure with a tendency toward compensation; (2) acute increase of intracranial pressure without a tendency toward compensation. Cases in the latter group included: epidural hematoma (7 cases), subdural hematoma (9 cases), combination of epidural and subdural hematomas (3 cases), and blockage (8 cases).

The symptomatology of increased intracranial pressure may be grouped according to three different types: (1) a symptom-free interval, delayed primary unconsciousness, and syndrome of acutely increasing pressure; (2) primary unconsciousness, a symptom-free interval, and secondary unconsciousness, etc.; (3) primary incessant unconsciousness.

The duration of the patients' stay at the hospital should be individualized. In this group patients without skull fracture usually stayed 8 to 24 days, while patients with fracture stayed 15 to 33 days.

Among the 27 patients showing increased intracranial pressure, 20 were operated upon, of whom 16 died. Twenty per cent were saved. The author believed that one-third of such cases might be saved by operation if the conditions were favorable. Chronic subdural hematoma should be evacuated subtemporally and the sac should be washed out.

The total mortality was 5.8 per cent (63 cases). Twelve patients (1.1 per cent) died of meningitis. The cases of meningitis were all associated with skull fracture. More than 50 per cent of the fatal cases died within twenty-four hours and about 80 per cent within three days. In order to improve the results of treatment, each case should be controlled carefully and the latest attainments of brain surgery should be available.

Haakon Saethre, Oslo, stated that certain individuals exhibit increased susceptibility to trauma. Among 316 cases, 13 (5 per cent) had had more than one head injury. Thirty per cent of the acute head injuries showed evidence of alcoholism, and in 122 cases of traumatic psychosis there were 44 cases of chronic alcoholism.

Commotio cerebri is defined as a clinical syndrome resulting from injury to the trunk of the brain (Berner). In cases of increased intracranial pressure edema plays a more important role than does hemorrhage. Among 258 cases of acute injuries, 62 per cent exhibited signs of this syndrome, but only 30.6 per cent of these were pure commotio syndrome. In the late material commotio syndrome was present in 71.6 per cent of 331 cases. Thirty-five per cent of the late material and 54.7 per cent of the acute cases exhibited neurologic suppression symptoms. In the acute cases nystagmus and other eye symptoms were predominant. In the cases with delayed symptoms otologic disturbances were most common. In 8 per cent of the late material disturbances of the olfactory and gustatory organs were present. Severe dementia was present in 3 cases. Traumatic epilepsy occurred in 5 per cent of the cases.

Meningoencephalopathy due to trauma should be diagnosed only on the basis of positive objective findings, such as neurologic symptoms, pathologic findings in the cerebrospinal fluid, or abnormal pneumogram.

The term "traumatic cerebral general syndrome" (Förster) is adequate for designating the subjective symptoms and should be distinguished from the term "post-traumatic neurosis," the latter being applied to cases without skull trauma. Patients with head injuries, however, may exhibit purely nervous symptoms.

The neuropsychologic symptoms in cases of trauma should be grouped as follows: (1) primary symptoms (primary conditioned psychoreflex, etc.); (2) secondary symptoms (associated with reactive hypochondria, querulousness, depression, etc.).

The author recommended centralization of observations, treatment, and evaluation of injury, especially in cases of patients with insurance.

Gunnar Rövig, Oslo, reported a series of 90 cases of head injuries in which pain persisted for long or short periods after the accident. All patients had undergone neurologic, ophthalmologic, acoustic-vestibular, and encephalographic examinations as well as measurements of spinal fluid pressure and chemical examination of the spinal fluid. Only patients who had been perfectly well before the accident were included. The majority of the patients complained of headache, vertigo, and psychic and vegetative disturbances. Tinnitus and ophthalmic or otologic disturbances were common. Eleven patients had epileptiform attacks. Objective examination revealed:

Psychic symptoms	55 cases
Cranial nerve disturbances	74 cases
Motor disturbances	14 cases
Disturbances of co-ordination	12 cases
Sensory disturbances	9 cases
Abnormal reflexes	58 cases
Ophthalmic disturbances and disturbances of eye muscles	51 cases
Acoustic-vestibular disturbances	26 cases
Pathologic cerebrospinal fluid (including increased pressure)	45 cases
Clinical intracranial lesions	18 cases
Positive encephalographic findings	20 cases
Aggravation or simulation symptoms	8 cases

The author emphasized the value of the encephalogram as an objective method of studying conditions after the injury. In making an interpretation of the findings, the results of the other examinations should be taken into consideration in order to arrive at a rational evaluation of craniocerebral damage.

S. A. Brofeldt, Helsingfors, related experiences with the treatment of skull fractures at the Red Cross Hospital of Finland. Among 1,076 cases with head injuries, there were 275 cases of skull fracture. Fifty-three of these died of brain injury, including 12 cases with meningitis. Five cases with meningitis survived. Fractures which communicated with the sinuses were treated by operation (trepanation and drainage of the sinus) if the skin was broken or if the anterior or posterior wall of the sinus was splintered. Cases with compound fracture of the skull involving the ear were treated conservatively unless an otitis developed. In cases with meningitis operation was performed.

J. Cedermark, Stockholm, reported upon a series of 1,960 cases with head injuries which had been treated at the Maria Hospital during the years 1920 to 1936. Among these, 153 patients had died during their hospital stay and 179 had died later. The cause of death in the latter group usually was not related to the injury. Autopsies had been performed in 109 cases. In the group of patients who had died in the hospital, death was due to the skull injury alone in 124 cases, while in 29 cases there were other severe injuries associated with the skull injury. Eighty per cent of the fatal cases died within forty-eight hours after the accident. The remaining 20 per cent died later from meningitis or pneumonia. The importance of conservative treatment in cases of fracture of the base of the skull in order to avoid meningitis was emphasized. In follow-up studies, 1,450 patients were re-examined, and approximately one-third of the entire group complained of persisting disturbances (one-half of the cases with skull fracture and one-fourth of the cases without fracture). Among 148 insured patients who complained of persistent disturbances, 27 per cent were judged to be entitled to compensation; 39

per cent of the insured patients and 36.7 per cent of the noninsured patients complained of disturbances.

Paul Fjeldborg, Vejle, reviewed observations made upon 287 patients with injuries of the skull in whom spinal puncture had been performed and who had been followed for one or two years after completion of the treatment. Among the patients who had been unconscious for one hour or less, there was blood in the spinal fluid in 144 and no blood in 117 cases; 46.5 per cent of the patients without blood and 54.7 per cent of those with blood in the spinal fluid were free from symptoms at the follow-up examinations. Only 4 of the 26 patients who had been unconscious for more than an hour showed no blood in the spinal fluid. Two of these, or 50 per cent, presented no late symptoms. In the 22 cases without blood in the spinal fluid, 36.4 per cent were free from late symptoms. Fjeldborg concluded that the presence or absence of blood in the spinal fluid was without prognostic value.

Otto Mikkelsen and **Fredrik Therkelsen,** Copenhagen, reported a series of 211 cases with head injuries and the results of follow-up examinations in 200 patients who had been treated at the Commune Hospital in Copenhagen during the period 1932 to 1934. Of the group of 211 patients at the time of admission, 163 had been considered to be uncomplicated cases of commotio cerebri, but subsequent studies revealed that only 58 per cent were "pure" cases; whereas, the others presented fracture of the skull, blood in the spinal fluid, and neurologic symptoms. Among the 200 patients who had been followed, 34 per cent complained of persistent headache and/or vertigo. Among 161 patients who had resumed work, 47 (29 per cent) complained of persistent headache or vertigo; 53 per cent of the patients manifested more or less severe disturbances after dismissal from the hospital.

Mogens Fog and **Axel Lund,** Copenhagen, discussed neurologic symptoms associated with acute trauma of the skull and stated that intracranial lesions were found often in patients who had been suspected of having only commotio cerebri. Sequelae were grouped into four classes: (1) chronic commotio syndrome (a morbid state due to organic damage; encephalograms or ventriculograms sometimes reveal abnormalities); (2) post-traumatic neurosis; (3) traumatic encephalopathy; and (4) post-traumatic epilepsy without other clinical indications of organic brain damage.

Björn Kristensen, Copenhagen, reported a series of 191 cases with fractures of the skull, treated at the Hospital in Sundby. There were 35 deaths. Death occurred within twelve hours in about 50 per cent and within forty-eight hours in 75 per cent of the fatal cases. The average period of hospitalization was three weeks. Examinations after two to five years revealed that 49 patients were free from symptoms, 12 manifested impaired working capacity, and 9 patients were judged to have 8 to 25 per cent disability.

Sigurd With, Copenhagen, stated that the treatment of uncomplicated commotio cerebri should be individualized. He reported a series of 394 cases treated at the Hospital in Sundby during the period 1924 to 1934. The patients were confined to bed only until the subjective symptoms had disappeared. In most cases (257) this was less than a week. Subsequently 16.1 per cent of the patients presented persistent complaints, but in most of the cases they were mild. There is no evidence to indicate a correlation between the intensity of the acute symptoms and the persistence of disturbances. The previous existence of neurosis is apparently not important. Sixty-six per cent of the patients returned to work within one month and 84 per cent were able to work within three months.

Einar Schie, Drammen, discussed the use of spinal puncture in cases of skull trauma. For two years all cases of skull injury had been treated by spinal puncture, intravenous injection of hypertonic glucose solution, and limitation of fluid intake. The results were better than in corresponding groups of patients treated by hypertonic glucose injection or bed rest alone.

In the discussion **Kristian Kristiansen,** Oslo, reported that neurologic examination of 209 patients with skull trauma revealed neurologic suppression symptoms in 67 per cent. Some of the symptoms disappear some days or weeks after the accident, indicating that they are caused by slight hemorrhages. Most frequently suppression symptoms are referable to the third, fourth, or sixth cranial nerve, but they may originate from the fifth, seventh, eighth, or ninth nerve. Treatment should be conservative. The injection of 25 per cent $MgSO_4$ is important. The total mortality was 5 per cent. Only 5.1 per cent of the cases were operated upon. The principal indication for surgical intervention is progressive unconsciousness. The operation is performed by removing a small portion of the skull subtemporally. Patients with severe brain injury and accelerated pulse should not be operated upon, because they do not survive operation. In patients with epidural hematoma operation should be performed as soon as possible, but in patients with subdural hematoma a period of observation should precede operation. Patients with skull fracture should rest in bed for at least three weeks.

M. Eirto, Helsingfors, stated that, among 540 cases studied at the Red Cross Hospital of Finland, primary unconsciousness was present in 90.4 per cent; 54.7 per cent exhibited amnesia with regard to the accident; 24.8 per cent exhibited alterations of the patellar reflex; and the Babinski sign was positive in 8.7 per cent. Respiration was irregular in 5.5 per cent, and 3 per cent of the cases exhibited Cheyne-Stokes type of breathing.

Marti Hämäläinen, Kuopio, called attention to the principles of physics in relation to traumatology. The important factor is kinetic energy, which is proportional to one-half of the product of mass times the square of the velocity.

H. Olivecrona, Stockholm, stated that trepanation should be performed upon the slightest suspicion of extra- or subdural hematoma. Openings should be made on both sides, over the anterior and posterior branches of the middle meningeal artery. He opposed desiccation therapy. The period of bed rest should not be too short, and subsequently the patient should be kept under strict control. Persistent symptoms are usually due to organic changes. Injuries in the region of the diencephalon cause especially prolonged disturbances. Such cases frequently have a lowered metabolic rate and often respond favorably to thyroid medication.

J. Hellstrom, Stockholm, discussed the difficulty of excluding the presence of extradural hematoma. He reported a patient who had been operated upon because he had developed unconsciousness after a symptom-free interval. No hematoma was found, but the patient died from fat embolism.

R. Ingebritzen, Oslo, approved the use of the term "traumatic neurosis" in patients with skull injuries. In some patients with a latent neurosis the trauma may operate to produce a symptomatic neurosis. He disagreed with Berner's assumption that hemorrhage into the fourth ventricle is the only cause of unconsciousness and death. Such hemorrhages may be found associated with other conditions, such as poisoning, and are not found in young animals killed by a blow on the head.

K. A. Lagergren, Hasselholm, reported 2 cases of pneumococcus meningitis which had developed after fracture of the skull and which had been successfully treated with a special compound pneumococcus serum.

H. Saethre, Oslo, disapproved of the use of the term "chronic commotio syndrome." Late symptoms are mostly organic and the symptom complex should be termed "traumatic cerebral general symptoms." The term "traumatic neurosis" is justified on condition that skull fracture is associated with other injuries.

P. Bull, Oslo, stated that observations on the large material collected and reported confirmed the fact that many symptoms which formerly had been considered to be due to aggravation and simulation really have an anatomic basis.

E. Landelius, Gävle, described a technique for spinal puncture which consisted of inserting the needle about 0.5 to 1 cm. to the right of the median line and advancing it in a medial and slightly cranial direction. He stated that this method decreased the risk of inserting the needle too far and that there were fewer failures than with median puncture.

H. Olivecrona, Stockholm, discussed the surgical treatment of Ménière's disease, and stated that medical treatment is usually unsuccessful. During a ten-year period, 60 cases were operated upon by Dandy's method of intracranial section of the vestibular nerve. There was no mortality, and recurrence of symptoms occurred in only 2 cases.

Einar Perman, Stockholm, discussed problems of military surgery, emphasizing the necessity for development of practical methods. Accommodations suitable for operating rooms should be provided, similar to the *"pavillons opératoires"* of the French army. Apparatus for sterilization should be adequate and should be installed in special cars. All severely wounded patients and those recently operated upon should be attended locally for at least eight days. Immediate transport of such cases increases the mortality.

John Holst, Oslo, discussed the indications for and results of treatment by extrapleural pneumonolysis and extrapleural pneumo-oleothorax: (1) tuberculous process too active to permit thoracoplasty, (2) extensive bilateral tuberculosis, (3) cavities near the hilus (when thoracoplasty gives unsatisfactory results), (4) contraselective pneumothorax.

Forty-six patients were operated upon with an operative mortality of 4.4 per cent; 38 patients were followed for four to twenty-one months. Among these, 28 showed no cavities and 22 (58 per cent) showed no bacilli. This method offers aid to patients who previously would have been placed in the inoperable group.

Gunnar Nystrom, Upsala, reported successful pneumonectomy for removal of a metastatic carcinoma the size of a fist in a woman, aged 61 years, who had been operated upon for cancer of the uterus ten years previously. Preliminary pneumothorax was instituted. The operative procedure was carried out under local anesthesia, supplemented with infusion of 2 c.c. of 10 per cent evipal in saline solution. Oxygen was administered by nasal catheter. Almost the entire seventh rib was resected. The pulmonary hilus was infiltrated with 3 per cent novocain and it was clamped with forceps. A transfixion ligature of catgut was applied, the hilus was cut with the diathermy knife, and the lung was removed. The mucous membrane of the bronchial stump was cauterized with a diathermic ball. The arteries and veins were then individually ligated, and two catgut ligatures were placed on the bronchial stump. The air was aspirated and the thorax was closed. There were no complications.

In the discussion, **John Holst,** Oslo, reported material covering 31 lobectomies with 4 postoperative deaths, and 6 pneumonectomies with 2 postoperative deaths.

John Holst, Oslo, reported 11 cases of mediastinal tumors and benign peripheral lung tumors which had been operated upon without any mortality. He stated that, if pneumothorax and thoracoscopy cannot be performed because of adhesions, broad lateral thoracotomy should be performed after the removal of one entire rib. Mediastinal tumors should be removed transpleurally except in the case of mediastinal struma. The latter should be removed by upper mediastinotomy after dividing the cartilage of the first, or up to the third, rib.

In the discussion, **Axel Odelberg,** Östersund, reported 2 cases of intrathoracic tumors, a ganglioneuroma and an echinococcus cyst. Both were operated upon and cured. The echinococcus cyst was removed by simple suction.

A case of mediastinal neurinoma, successfully removed, was reported by **R. Ingebritzen,** Oslo.

G. Nystrom, Upsala, pointed out that single-stage operations for echinococcus cyst are attended with risk of serious allergic collapse, because the cyst contents may enter the open pleural cavity.

E. Akerberg, Örebro, discussed the treatment of bleeding ulcers and presented material based upon 140 operations for hemorrhage during the period 1929 to 1938. The mortality was 13 per cent, or twice as high as for operations in a hemorrhage-free interval. Roentgen examinations were carried out during the stage of bleeding in more than 95 per cent of the cases (295 examinations) and caused no damage. Blood transfusion did not exert a hemostatic effect. Follow-up examinations of 168 cases of gastric resection (chiefly Billroth I) in patients who had been operated upon during, or shortly after, the stage of bleeding, revealed that recurrent hemorrhages occurred in almost 20 per cent. It is, therefore, important to study and evaluate the symptoms and to limit the indications for operation.

In the discussion, **G. Bohmansson,** Örebro, stated that blood transfusion may cause renewed bleeding.

Axel Christensen, Aker, discussed the immediate results of surgical treatment of chronic gastric ulcers. The material included 1,100 cases treated medically during the period 1924 to 1938, and 422 cases treated surgically during the period 1915 to 1939. In the first group there were 19 deaths and in the latter group (434 operations) there were 16 deaths, including 2 from hemorrhage. The author assumed that one-half of the patients treated medically were cured, while the remaining half of the group manifested persistent symptoms indicating necessity for operation. On this basis the mortality in patients treated medically is comparable to that following surgical treatment. The operative mortality is 3.7 to 3.8 per cent and is equally divided between resections and gastroenterostomies. Most of the deaths are due to technical deficiencies. The author's personal cases included 254 patients with 5 deaths, a mortality of less than 2 per cent. Resection is the method of preference (Billroth II). Gastroenterostomy should be performed only in cases of pyloric stenosis and in patients over 50 years of age. The author emphasized the importance of postoperative dietary management and of the use of local anesthesia and routine drainage for twenty-four hours following operation. Since the introduction of the use of routine drainage in 1930, no death from peritonitis has occurred. Follow-up examinations revealed good results in 60 per cent of cases following gastroenterostomy and in 86 per cent following resection.

In the discussion, **E. Landelius,** Gävle, stated that 638 operations had been performed for ulcer at the hospital in Gävle between the years 1928 and 1937. There had been 47 deaths (7.4 per cent mortality); 110 perforated ulcers had been operated upon, with 16 deaths. Resection (Billroth II or Reichel) had been performed in 415 cases. Resection should be performed in young patients and at an early stage of the disease. The patients should be given a normal mixed diet including vitamins.

N. Backer-Gröndahl, Bergen, described and demonstrated a kidney rest, made of stainless steel, which permitted fixation of the patient's pelvis in any desired oblique position. He recommended it especially for operations performed under spinal anesthesia.

G. Levander, Köping, discussed the relationship of periosteum to bone repair. Periosteum had been implanted subcutaneously in very young rabbits. The cambium layer disintegrated, irrespective of whether it was implanted alone or together with bone tissue. It encouraged bone repair in the same manner as the fully developed

bone tissue. The author assumed that it contained a bone-repairing substance which encouraged the mesenchyma to bone repair. The cambium layer might be correctly qualified by the term, "accretion of the bone tissue of mesenchyma type."

S. Annersten, Upsala, discussed the biochemistry of bone formation. He had used the method of developing heterotopic bone formation by bone extract and assumed that the process was caused by a substance with hormonelike action. This substance is soluble in alcohol and is probably of lipoid nature; it can be isolated by concentration and is not type specific. Chemical studies were carried out with regard to the relation of calcium, carbonic acid, and phosphorus to the callus. The findings suggested certain points which may help to clarify the problem of increasing alkali reserve and of alkaline pH of the tissues of the callus.

Alf Gundersen, La Crosse, Wis., presented data concerning transurethral prostatic resection in 100 patients over 75 years of age. The postoperative mortality was 5 per cent. Follow-up examination of 76 patients revealed satisfactory results in 72 cases. The prostate should be removed by radical operation (four-fifths of the gland); bleeding should be meticulously controlled; and asepsis is of great importance.

In the discussion, **Stein F. Holst,** Oslo, stated that 403 patients had been treated for disturbances of the prostate at the Vor Fru Hospital during the past seven years. The operative mortality of transurethral resection was 3.8 per cent, and of prostatectomy was 9 per cent. Sixty-three of the patients were over 75 years of age.

Thesis III. Epiphyseolysis Capitis Femoris. The discussion was introduced by **Henning Waldenström,** Stockholm, and **Poul Morville,** Copenhagen.

H. Waldenström, Stockholm, stated that epiphyseolysis, gradual gliding, and dislocation of the epiphysis of the hip joint are synonymous terms indicating dislocation of the epiphysis caused by some deficiency of the solidity of the bone layer extending from the cartilage of the epiphysis to the metaphysis. The action of the muscles and the weight of the body cause dislocation of the epiphysis backward and downward, the cup-shaped epiphysis rotating around the metaphysis; the femur is pushed upward, rotating outward. Endocrine disturbances are probably the causative agents of this process. This assumption is supported by the facts that: (1) one-third of the cases occur in the adiposogenital type; (2) dislocation occurs only during puberty; (3) the affection is bilateral in one-fourth of the cases; and (4) two-thirds of the cases develop the disease without any external injury. The dislocation does not occur suddenly; there is a gradual slipping. If diagnosis be established early, proper treatment may give favorable results. Every boy or girl limping ever so slightly should be carefully examined, and if the slightest restriction of mobility is found, an x-ray examination should be carried out, including lateral films. The lower part of the epiphysis glides over the metaphysis, covering it like a claw. The epiphyseal line is broad. If the epiphysis heals at this stage and its position is securely fixed, the hip joint will become normal. As long as the endocrine disturbance persists, a renewed dislocation in one or the other direction may occur. In the lecturer's own experience 25 per cent of the cases were bilateral, and the epiphysis tended to shift its position for about one and one-half years, but not longer. Pressure against the epiphysis must be eliminated, especially at the beginning of the process, in order to permit the epiphysis to heal and become fixed as soon as possible. Adhesive plaster extension should be applied for two to three months. After this period the patient should walk with crutches and without weight-bearing on the injured extremity for four to eight months, and finally he should walk with the aid of sticks until the dislocation process stops, which, as a rule, occurs at the end of a year. It is important to allow some mobility within the hip joint. Adhesive plaster extension permits this, but plaster of Paris does

not. So-called reposition performed under anesthesia is usually unsuccessful and also carries a risk of destruction of the joint (caput necrosis) in 20 per cent of the patients. Skeletal traction by means of a wire through the femoral condyles, without internal rotation, may be used, but not for longer than ten days.

Poul Morville, Copenhagen, stated that epiphyseolysis usually develops gradually, but it may appear acutely following trauma in a patient with latent disturbances. The slipping process comes to a stop when synostosis between the caput and collum develops. Follow-up examination after two to fifteen years following treatment reveals that many cases are improved, but many also show disturbances. Some patients develop a secondary arthritis of the hip at an early age. There is doubt whether manipulation yields any better results than prolonged bed rest without any attempt at correction. Manipulation does not correct rotation between collum and caput; the apparent reposition is due to the collum's being pressed into the caput. Traumatic arthritis may develop. Treatment by extension probably interferes with synostosis between caput and collum. In mild cases with slight dislocation drilling through the collum femoris may help to stop the slipping and to develop synostosis within two or three months. In cases of moderate or extensive dislocations, traction should be applied for a short time followed by drilling. In neglected cases with extensive dislocation, osteotomy should be performed.

In the discussion, **N. A. Nicolayson,** Bergen, expressed the opinion that bloodless reposition is possible and is justified in cases of extensive dislocation, especially in cases with traumatic epiphyseolysis presenting a short history. He reported 18 cases, 9 treated by reposition and 9 by conservative methods. The cases treated by reposition exhibited more favorable results.

H. Camitz, Göteborg, stated that plaster of Paris may be applied in rare cases when the dislocation is not more than two or three weeks old. When conservative treatment is unsuccessful, osteotomy should be used to correct the external rotation.

H. Döhlen, Oslo, stated that tall, heavy individuals with weak body structure and clumsy movements present this affection. Treatment should vary with the duration of the dislocation. In a series of 10 cases, 6 had been treated after two months by reposition and application of plaster of Paris with excellent results; 1 case treated after ten weeks by reposition was unsatisfactory; and 3 later cases were not treated.

H. Thrap-Meyer, Oslo, reported epiphyseolysis in a father (bilateral) and son (unilateral). In both cases the disease appeared at the usual age and was occasioned by relatively light trauma. The son was treated by open operation, and after two years the bending capacity was satisfactory, but mobility in the horizontal plane was reduced.

P. G. K. Bentzon, Aarhus, presented stereoscopic roentgenograms to support his contention that reposition under anesthesia may be a proper procedure. None of his cases treated in this manner had manifested symptoms of insufficiency, nor did roentgenograms reveal pathologic changes. The method of treatment should not be evaluated on the basis of improperly treated patients who had been immobilized in plaster of Paris in a position of forced internal rotation and abduction. Criteria of successful reposition are unimpeded internal rotation and stereoscopic roentgenograms showing proper position. Arthritis does not occur after a properly performed and successful reposition, but it is likely to occur in untreated cases.

G. Bohmansson, Oslo, advocated the method of slow extension in cases of epiphyseolysis. If reposition is required, spinal anesthesia is preferred. The lecturer had inserted three or four metal bars for the purpose of support and maintenance of position in 4 cases. The results had been good in 2 of these.

A. Brekke, Stavanger, reported a patient who had remained symptom-free two years after bloodless reposition. Cases of extensive, acute dislocation following trauma are more suitable for bloodless reposition than those with a slow slipping process.

J. Waldenström, Falun, suggested that better results might be obtained if the patients could be centralized in orthopedic departments.

F. Langenskiöld, Helsingfors, opposed drilling and nailing and used reposition methods in only a few cases when extensive dislocations were due to severe trauma. As a rule his treatment consisted of the application of a walking apparatus which protected the joint.

Guidal, Copenhagen, stated that it is not clear which method of treatment is best. Genuine dislocations of the epiphysis are not suitable for operation. Osteotomy is indicated in neglected cases.

Henning Waldenström, Stockholm, stated that most of the roentgenograms which had been shown were taken in such a manner that no conclusions concerning the results of reposition could be drawn from them. Neither did they show any evidence that necrosis is common following reposition. If the epiphysis is closed or almost closed, as the majority of roentgenograms showed, an attempt at reposition could not cause necrosis, but neither is reposition possible at this stage in most cases. It appears, however, from the statements expressed in the opening lectures that so-called reposition causes necrosis and destruction of the joint in many cases.

P. Morville, Copenhagen, advocated gradual extension rather than reposition under spinal anesthesia for epiphyseolysis. The patient should be controlled and treated until the roentgenogram shows synostosis.

E. Platou, Oslo, read a paper concerning experiences with the Smith-Petersen acetabuloplastic procedure. This has been published in *Nordisk Medicin,* 1940.

F. Teilmann, Gram, reported a case of vertebra plana in a 5-year-old boy. Two Norwegians, **Bülov-Hansen** and **Heyderdal,** described a case of this disease prior to Calvé's report. Not more than 20 cases have been reported, and most of them from Scandinavia. The disease is assumed to be an aseptic bone necrosis caused by some unknown factor. Diagnosis is established by the roentgenogram. The treatment is the same as for tuberculous spondylitis. The prognosis is good. The patient should be carefully controlled when he becomes ambulatory and when he is permitted to discard his corset.

In the discussion, **Halfdan Sundt,** Stavern, stated that it is difficult to decide whether such cases should be treated at all. Most of them show complete clinical recovery whether they are treated or not. Protection of the affected area is one of the important points of treatment. He had seen 1 patient with this condition.

Sven Johannson, Göteborg, pointed out that steel is the most widely used maerial for osteosynthesis because of its strength and resistance to corrosion. He had experimented with various types of chromium-nickel steel and had found that an alloy, including 60 per cent nickel, 15 per cent chromium, and 16 per cent iron, was most suitable. The resistance to corrosion was measured by placing the material into a physiologic solution of salt containing 1 per cent of gum arabic and 0.02 per cent of potassium ferricyanide. The amount of ferroferricyanide produced was determined colorimetrically.

Einar Ljungren, Sollefteå, discussed the diagnosis and treatment of tuberculous epididymitis and reported 68 cases treated at the Maria Hospital in Stockholm (Key). In 34 cases the affection was associated with tuberculosis of the kidneys, and renal lesions always should be sought for in cases of tuberculous epididymitis. The primary genital lesion frequently is in the prostate or seminal vesicles. Urethrographic examination is important, and in 28 patients it showed 14 cases

with cavity formations in the prostate. Most of the patients were treated by epididymectomy, if possible, or by orchidectomy. Early operation is desirable. General hygienic and dietetic measures should be applied. Twenty-seven per cent of the cases treated by operation died within five years, most of them from tuberculosis.

In the discussion, **J. Hellström,** Stockholm, stated that, if the diagnosis of tuberculous epididymitis is doubtful, epididymectomy should be performed. Even septic epididymitis sometimes develops very slowly. Patients suffering from epididymitis frequently respond well to injections of neosalvarsan.

Helge B. Wulff, Lund, discussed the treatment of tuberculous lymphadenitis of the neck, based upon a series of 222 cases treated by surgery (100 cases) or by x-ray (122 cases). The patients were followed for periods of six to ten years. The recurrence rate was the same for both groups (13 per cent). Seventy-eight per cent of the cases treated surgically and 63 per cent of the cases treated by x-ray were cured. It is advisable to individualize when selecting the method of treatment.

Gunnar Nyström, Upsala, demonstrated a method of multiple nailing for fracture of the neck of the femur, which had been used in 30 cases at the Out-Patient Department of the University of Upsala. Comparatively small, stainless steel nails had been used. The method seemed to carry less risk of dislocation of the fragment and of the nail than in the case of the Smith-Petersen nail.

In the discussion, **J. Hellström,** Stockholm, stated that, among 99 cases of osteosynthesis for fracture of the neck of the femur at the Maria Hospital, the following complications had been observed. In 8 cases the head had rotated when the nail was driven in; necrosis of the head had occurred 5 times; the nail had broken in 1 case six months after the operation; the nail had been driven into the acetabulum in 5 cases and had slipped out 16 times. Such complications might be avoided by applying the method proposed by Nyström.

Anton Poulsson, Oslo, demonstrated an apparatus for directing the nail in cases of fracture of the neck of the femur. It had been used in 42 cases, and in every case an ideal position had been obtained at the first operation.

In the discussion, **B. Bager,** Stocksund, pointed out that he had described a simplified method of osteosynthesis in *Der Chirurg,* 1939.

G. Levander, Köping, described the operative treatment of pseudoarthrosis by transplantation of living bone tissue. He used a paste made of thin strips of bone chiseled from the lateral aspect of the tibia and bone flour and blood obtained by drilling. This was applied to the defect in the bone. In 5 cases treated by this method there was satisfactory bone repair. The healing process required about two months.

N. Silfverskiöld, Stockholm, summarized the characteristic features of tumors of the synovia. They develop very slowly and present diagnostic difficulties. They show a tendency to metastasize, and the prognosis is grave. Amputation should be performed immediately upon making the diagnosis, and postoperative radium therapy should be applied to the regional lymph nodes. The author had seen 3 cases of synovial tumors.

Smith-Petersen, Boston, delivered a lecture concerning arthroplasty of the hip by a method based upon a new surgical principle.

The next Congress is to be held in Helsingfors in 1942. Professor Brofeld was elected president of this Congress. The following theses are to be presented: Thesis I. Arthritis Deformans From the Surgical and Orthopaedic Point of View; Thesis II. Acute Surgical Diseases of the Abdomen Associated With Pregnancy; Thesis III. Peripheral Vascular Disease, With Special Consideration of Arthritis Obliterans.

The membership of the society is 538; 45 new members were accepted, 19 had died, and 11 had resigned.

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Book Reviews

Diagnosis and Treatment of Head Injuries. By Sidney W. Gross and William Ehrlich. Cloth. Pp. 275, with 94 illustrations. New York, 1940, Paul B. Hoeber, Inc. $5.

The authors state that this book attempts to present to the physician or surgeon of average training a practical and concise approach to the problem of head injury.

Beyond doubt, this purpose has been accomplished. The book is concise and thoughtfully developed. Brevity is attained by careful elimination of subject matter rather than by uniform abridgement of a great number of headings. There are some changes, however, which the authors may wish to make in later editions.

The chapters dealing with the gross anatomy and physiology of the brain could well be expanded to furnish a better understanding of the controversial aspects of treatment and the chapter on gunshot injuries might well be enlarged with material from the War Abstracts.

The chapter concerning surgical technique is of questionable propriety or value. Technique cannot be well learned from so brief a text as this and it is doubtful that such technique would be usable by the average practitioner to whom the book is devised.

The general principles of treatment are stated with due consideration for the conflicting current ideas and the discussion of extradural and subdural hemorrhage is comprehensive, clear, and remarkably complete for so small a book.

Considered as a compendium, the book is valuable and interesting, and with its bibliography provides an excellent introduction to the field of craniocerebral trauma.

Obstetrics in General Practice. By J. P. Greenhill, M.D. Cloth. Pp. 448, with 112 illustrations. Chicago, 1940, The Yearbook Publishers. $3.50.

This book cannot, as Greenhill admits in his preface, compete with the standard textbooks on obstetrics. It does cover, however, the basic facts of obstetric care and the more commonly encountered obstetric complications. There can be no doubt that the present high maternal and fetal mortality rates are due in large measure to the imperfect knowledge of these fundamental principles. They are here presented in easy style and generally as well-recognized facts, being shorn of historical data, anatomy, and pathology. Certainly, if all the contained data were known and practiced by each physician doing obstetrics as a part of general practice, there should be definite improvement noted in statistical expressions of obstetric care. However, there can be no justification for a book of this kind other than that some uninformed members of the profession might refer to it rather than acquire a broader knowledge from one of the more thorough standard textbooks.

The chapter on ante-partum care is particularly wholesome in that it emphasizes the responsibilities of the one accepting the obstetric patient. Thoroughness as a routine is emphasized throughout this chapter and he who is unwilling to do this should not be intrusted with the lives of two individuals in a single case.

Conservatism is suggested in treatment of almost all obstetric complications and therapeutic abortion for active pulmonary tuberculosis is frowned upon. However, the suggested radical treatment of missed abortion would seem to have little to justify it in the light of infrequent or absent serious complications. The suggested conservatism with analgesia and anesthesia is a timely warning and well-founded reasons are given for the use of local infiltration and for keeping analgesia at a minimum. Up-to-the-minute classification of the toxemias of pregnancy and treatment of pyelitis and puerperal infection with chemotherapy are included. Of particular importance is the thorough treatment of hydatidiform mole with curettage followed by prolonged biological tests for evidence of chorionepithelioma.

The general tone of the whole book is one of simplicity, often to the point of sacrificing such strict and fundamental terminology as presentation of the fetus and presenting part.

Proctoscopic Examination and Diagnosis and Treatment of Diarrheas. By M. H. Streicher, M.D. Pp. 149, with 39 illustrations. Springfield, Ill., 1939, Charles C. Thomas, Publisher. $3.

This is a single volume monograph of 149 pages, comprising seven chapters. It is printed on good paper and is very readable.

Under "Armamentarium" various instruments are suggested. I feel that there are many instruments that the author uses efficiently, the ones with which the operator is most familiar being the ones he should use. The man doing general work should familiarize himself with instruments as outlined. The importance of doing proctoscopic examinations is stressed, as it certainly should be, for there is no part of an examination so commonly neglected. The author's preparation and technique for proctoscopic examination are well described. Lesions are discussed and case reports are cited and treatment outlined. This volume is well illustrated with drawings and x-ray film reproductions. While not presenting anything particularly new, it is well worth reading and will not require more than part of an evening. The insistence on the examination of the rectum is commendable.